BROADBAND ISOTROPIC RADIATION MONITOR

Model 8600 Series
OPERATION & MAINTENANCE MANUAL

CAUTION

Read this Manual before operating the unit. This manual contains operating safety information required to protect the operator and the equipment when making electromagnetic leakage tests.

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THE NARDA MICROWAVE CORPORATION
HAUPPAUGE, NEW YORK 11788

OWNER'S RECORD

Meter Model # _____

S/N _____ Calibration Date _____

Probe Model # _____

S/N _____ Calibration Date _____

Probe Model # _____

S/N _____ Calibration Date _____

Probe Model # _____

S/N _____ Calibration Date _____

Probe Model # _____

S/N _____ Calibration Date _____

Check Source Model # _____

S/N _____

Model 8600 Series
OPERATION & MAINTENANCE MANUAL

U.S. Patent Nos.

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4629978
4023093
3641439
1357294
DES 223293
G.B. 1326243
DES 262360
Canada 950041
Additional Foreign Patents

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TABLE OF CONTENTS

Section			Page
I	INTRODUCTION		1-1
	1-1.	General	1-1
	1-2.	Description, Meters	1-1
	1-3.	Description, Electric Field Probes	1-3
	1-4.	Description, Magnetic Field Probes	1-4
	1-5.	Equipment Supplied	1-4
	1-6.	Model 8616 Radiation Meter Specifications	1-9
	1-7.	Model 8611 Radiation Meter Specifications	1-10
	1-8.	Model 8699 Check Source Specifications	1-10
II	OPERATION		2-1
	2-1.	General	2-1
	2-2.	Preliminary Inspection	2-1
	2-3.	Model 8616 Control Panel Description	2-1
	2-4.	Model 8611 Control Panel Description	2-1
	2-5.	General Operating Information	2-6
	2-6.	Full Scale Ranges	2-14
	2-7.	Pre-Operation — Model 8616 Meter	2-15
	2-8.	Pre-Operation, Model 8611 Meter	2-17
	2-9.	Peak Power Ratings	2-18
	2-10.	Static Charged Areas	2-19
	2-11.	Zero Drift	2-21
	2-12.	Operating Procedure	2-21
	2-13.	Remote Operation (8616)	2-22
	2-14.	AC Operation	2-23
	2-15.	Max Hold Mode of Operation (8616)	2-24
	2-16.	Meter Response Selection (8616)	2-24

TABLE OF CONTENTS (CONT)

Section			Page
III	THEORY OF OPERATION		3-1
	3-1.	General	3-1
	3-2.	Battery Test (8616)	3-4
	3-3.	Battery Test (8611)	3-4
	3-4.	Magnetic Field Probes: Models 8631, 8633, 8652, and 8654	3-4
	3-5.	Electric Field Probes: Models 8621, 8623, 8661, 8662B and 8682	3-6
	3-6.	8682 Probe Description	3-8
	3-7.	Meter Input Amplifier (8616)	3-17
	3-8.	Meter Alarm Section (8616)	3-17
	3-9.	Indicator Circuits (8616)	3-17
	3-10.	Auto-Zero	3-18
	3-11.	Power Supply	3-18
	3-12.	Battery Charging Circuit	3-19
	3-13.	8699 Description	3-19
IV	MAINTENANCE		4-1
	4-1.	General	4-1
	4-2.	Cleaning	4-1
	4-3.	Required Test Equipment	4-2
	4-4.	Meter Zero	4-2
	4-5.	Power Supply Test	4-2
	4-6.	Zero Offset Adjustments	4-3
	4-7.	Zero Offset	4-3
	4-8.	Alarm Calibration	4-3
	4-9.	Meter Response	4-4
	4-10.	Range Calibration	4-4
	4-11.	Recorder Output	4-5
	4-12.	Battery Charge Current	4-5
	4-13.	Maximum Hold Operation	4-5
	4-14.	Required Test Equipment, Models 8631, 8633, 8652, and 8654	4-6
	4-15.	Power Requirements	4-8

TABLE OF CONTENTS (CONT)

Section		Page
4-16.	Initial Calibration Procedure (27 MHz) for Models 8631 and 8633	4-8
4-17.	Frequency Calibration	4-9
4-18.	Calibration Potentiometer Access Procedure	4-9
4-19.	Required Test Equipment — 500 MHz to 1 GHz Calibrations	4-10
4-20.	Calibration Procedure — 500 MHz to 1 GHz	4-11
4-21.	Required Test Equipment, 1.7 to 40 GHz Calibrations	4-12
4-22.	High Frequency Probe Calibration, Models 8621/8623	4-14
4-23.	Frequency Alignment	4-15
4-24.	Troubleshooting	4-16
4-25.	Model 8616 Battery Charging	4-16
4-26.	Model 8616 Battery Replacement	4-16
4-27.	Model 8611 Battery Replacement	4-17
4-28.	Model 8616 Printed Circuit Board Components and Front Panel Replacement	4-20
4-29.	Model 8616 Meter Replacement	4-21
4-30.	Model 8699 Battery Replacement	4-21
V	STORAGE	5-1
5-1.	Introduction	5-1
VI	PREPARATION FOR RESHIPMENT	6-1
6-1.	Introduction	6-1
6-2.	Procedures	6-1

TABLE OF CONTENTS (CONT)

Section			Page
VII	REPLACEMENT PARTS LIST	.....	7-1
	7-1. Introduction	.....	7-1
	7-2. Ordering Information	.....	7-1
	7-3. Customer Repair Service	.....	7-1

LIST OF ILLUSTRATIONS

Number	Title	Page
1-1	Model 8616 Meter with Models 8631 and 8623D Probes	1-2
1-2	Model 8611 Meter with Model 8662B Probe	1-2
2-1	Model 8616 Front Panel	2-2
2-2	Model 8611 Front Panel	2-4
2-3	Power Density to Electric Field Strength	2-9
2-4	Power Density to Magnetic Field Strength	2-10
2-5	Meter Faces are Designed with Color-Coded Decals that Group Probes by Power Range	2-14
2-6	Maximum Peak Power Density Nomograph	2-21
2-7	Remote Voltage Operated Indicator	2-23
2-8	Remote Current Operated Indicator	2-23
3-1	Simplified Block Diagram	3-2
3-2	Low Frequency System Portrayal	3-3
3-3	Models 8631, 8633, 8652 and 8654 Lumped Equivalent Circuit	3-5
3-4	Relationship of the Three Mutually Orthogonal Probe Elements. Probe Elements are Contained Within a 5 cm Sphere	3-8

LIST OF ILLUSTRATIONS (CONT)

Number	Title	Page
3-5	Lumped Equivalent Circuit of the Probe with Single Elements Relative to the Total Probe. R2 Represents One of the Distributed Thermocouples	3-9
3-6	Lumped Equivalent Circuit of Dipole-Diode Sensors	3-10
3-7	Equivalent Circuit for 30 to 1000 MHz	3-11
3-8	Equivalent Circuit for 3 to 30 MHz	3-11
3-9	Equivalent Circuit for Frequencies Below 3 MHz	3-12
3-10	Pictorial View of Dipole Showing Resistive and conductive Segments	3-12
3-11	Equivalent Circuit for 300 MHz to 1.5 GHz	3-14
3-12	Frequency Response of Probe with ±2dB Margins Conforming to C95.1-1982 Standard	3-15
3-13	Out of Band Response	3-16
3-14	Model 8616 Radiation Monitor Schematic and PC Board Layout	3-20
3-15	Models 8631/8633, 8621/8623 Probe Schematic	3-22
3-16	Models 8652 and 8654 Probe Schematic	3-23
3-17	Models 8661, 8662B, and 8682 Probe Schematic	3-24
3-18	8611 Radiation Monitor Schematic	3-25
4-1	Test Set-Up	4-4
4-2	Low Frequency Probe Calibration Test Set-Up for .3 to 500 MHz	4-7
4-3	Probe Pre-Amplifier	4-11
4-4	Calibration Test Set-Up for 500 MHz to 1.0 GHz	4-12
4-5	Calibration Test Set-Up for 1.1 to 2.6 GHz Frequency Range	4-22

LIST OF ILLUSTRATIONS (CONT)

Number	Title	Page
4-6	Electromagnetic Test Set-Up for 1.7 to 5.8 GHz	4-23
4-7	Calibration Test Set-Up for 5.4 to 8.2 GHz Frequency Range	4-24
4-8	Calibration Test Set-Up for 8.2 to 12.4 GHz Frequency Range	4-25
4-9	Calibration Test Set-Up for 12.4 to 18.0 GHz Frequency Range	4-26
4-10	Calibration Test Set-Up for 18 to 26 GHz Frequency Range	4-27
4-11	Calibration Test Set-Up for 26 to 40 GHz Frequency Range	4-28

LIST OF TABLES

Number	Title	Page
1-1.	Equipment Supplied with Model 8616	1-5
1-2.	Equipment Supplied with Model 8611	1-5
1-3.	PROBE SPECIFICATIONS/Electric Field	1-6
1-4.	PROBE SPECIFICATIONS/Model 8682	1-7
1-5.	PROBE SPECIFICATIONS/Magnetic Field	1-8
1-6.	MODEL 8616 RADIATION METER SPECIFICATIONS (excluding probes)	1-9
1-7.	MODEL 8611 RADIATION METER SPECIFICATIONS (excluding probes)	1-10

LIST OF TABLES (CONT)

Number	Title	Page
2-1.	Model 8616 Front Panel Control and Indicator Functional Description	2-3
2-2.	Model 8611 Front Panel Control and Indicator Functional Description	2-5
2-3.	Power Density Conversion Table	2-11
2-4.	Conversion of Power Density (Free Space) to Field Strength	2-12
2-5.	Conversion of Power Density in mW/cm^2 to Other Parameters Based Upon Free Space Conditions	2-13
4-1.	Transmitted Power Requirements	4-15
4-2.	Model 8616 Troubleshooting Chart	4-18
4-3.	Model 8611 Troubleshooting Chart	4-20
7-1.	Manufacturer's Code	7-2
7-2.	Replaceable Parts List	7-3

SECTION I
INTRODUCTION

1-1. GENERAL

This manual contains complete instructions for the operation of the Model 8600 Series Broadband Isotropic Radiation Monitoring Systems. Each system is comprised of a metering instrument and, depending upon the application, one or more field sensitive probes. All probes and meters are interchangeable. Typical systems, shown in Figure 1-1 and Figure 1-2, are manufactured by The Narda Microwave Corporation, Hauppauge, New York. This manual includes a general description of the equipment, operating instructions, and servicing procedures.

1-2. DESCRIPTION, METERS

1-2.1 Model 8616

The Model 8616 is our full-featured metering instrument. In addition to the basic functions of range selection and battery test, the Model 8616 offers additional features for functionality and operator convenience. The meter is a large 4 inches wide, and easy to read. Zeroing is accomplished automatically by a single pushbutton located on the carrying handle provided. An audible power density alarm is included, along with a front panel control which the operator may use to set the alarm threshold anywhere between 0 and 100% of the full scale meter reading. The Max-Hold function enables the meter to display the highest reading encountered during the survey and a chart recorder output permits the creation of permanent records of survey results or the interface with other equipment. Both the chart recorder and alarm outputs follow the real-time indication, independent of the utilization of the Max-Hold function. System response time is selectable between one and three seconds to suit the particular application. The Model 8616 also includes built-in rechargeable batteries and recharger. The unit may be operated from 117 or 230 VAC, and will recharge the batteries while operating. The meter will operate on the batteries for 40 hours on a charge, with a 3:1 use to charge ratio.

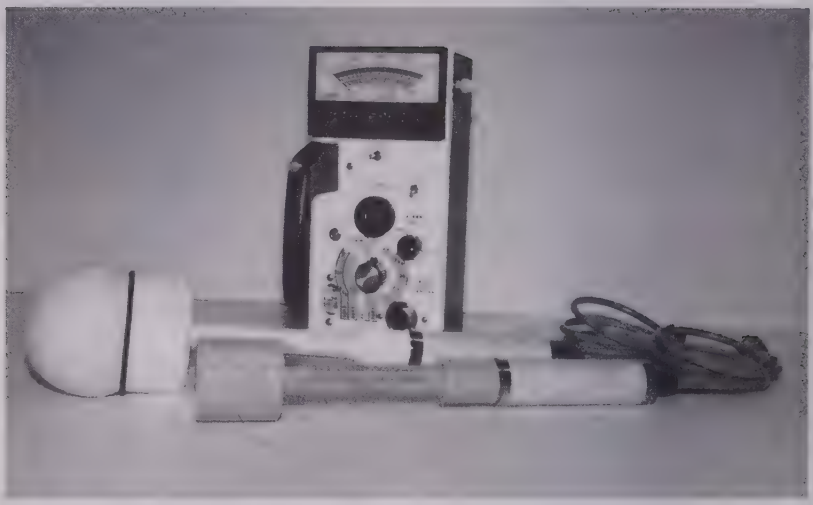


Figure 1-1. Model 8616 Meter with Models 8631 and 8623D probes.

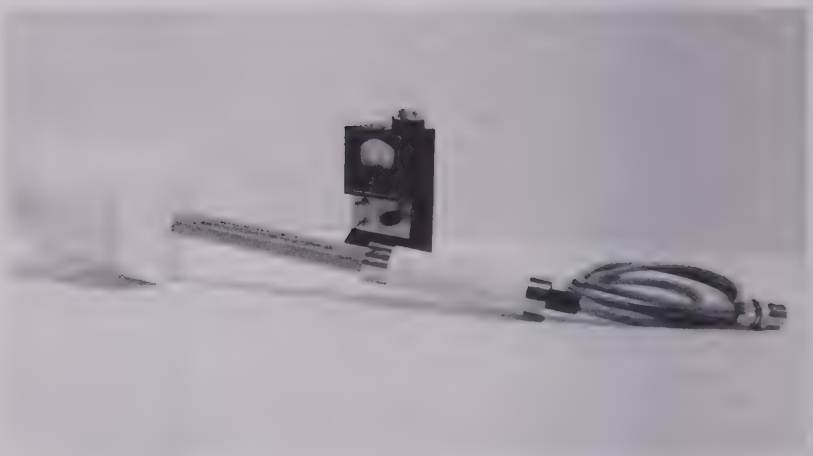


Figure 1-2. Model 8611 Meter with Model 8662B probe.

1-2.2 Model 8611

The Model 8611 is a compact unit which provides all the basic functions required for radiation hazard monitoring. The readout is calibrated in equivalent power density units (mW/cm^2) and % of standard; a range selector allows for a choice among three ranges. A battery test function and meter zero control are also provided. The meter operates up to 500 hours on the disposable batteries used.

1-3. DESCRIPTION, ELECTRIC FIELD PROBES

1-3.1 Model 8621D

Model 8621D High Frequency Isotropic Probe provides flat, accurate electric field equivalent power density measurements over the frequency range of 300 MHz to 40 GHz. 14 Calibration points are provided over this range. Model 8621D provides full scale ranges of 0.2 mW/cm^2, 2.0 mW/cm^2 and 20 mW/cm^2.

1-3.2 Model 8623

Model 8623 High Frequency Isotropic Probe provides flat, accurate equivalent power density measurements over the frequency range of 300 MHz to 40 GHz. 14 Calibration points are provided over this range. Model 8623D provides full scale ranges of 1.0 mW/cm^2, 10 mW/cm^2 and 100 mW/cm^2.

1-3.3 Model 8661

Model 8661 Low Frequency Isotropic Probe has a flat frequency response which permits accurate electric field equivalent power density measurements over the 300 kHz to 1000 MHz range. Model 8661 provides full scale ranges of .2 mW/cm^2, 2.0 mW/cm^2, and 20 mW/cm^2.

1-3.4 Model 8662B

Model 8662B Low Frequency Isotropic Probe has a flat frequency response which permits accurate electric field equivalent power density measurements over the 300 kHz to 1000 MHz range. Model 8662B provides full scale ranges of 2.0 mW/cm^2, 20 mW/cm^2, and 200 mW/cm^2.

1-3.5 ANSI Conformal Probe.

Model 8682 Electric Field Probe has a frequency range from 0.3 MHz to 1500 MHz with a sensitivity characteristic that is the inverse of the C95.1-1982 ANSI Radio Frequency Protection Guide. It provides metering in percent of exposure limit. A range decal and selector knob provide proper scaling for this probe.

1-4. DESCRIPTION, MAGNETIC FIELD PROBES

1-4.1 Model 8631

Model 8631 Isotropic Probe provides flat, accurate magnetic field equivalent power density measurements over the frequency range of 10 to 300 MHz. Model 8631 provides full scale ranges of 0.2 mW/cm^2, 2.0 mW/cm^2 and 10 mW/cm^2.

1-4.2 Model 8633

Model 8633 Isotropic Probe provides flat, accurate magnetic field equivalent power density measurements over the frequency range of 10 to 300 MHz. The Model 8633 provides full scale ranges of 1.0 mW/cm^2, 10 mW/cm^2 and 100 mW/cm^2.

1-4.3 Model 8652

Model 8652 Low Frequency Isotropic Probe has a flat frequency response which permits accurate magnetic field equivalent power density measurements over the 300 kHz to 10 MHz frequency range. Model 8652 provides full scale ranges of 2.0 mW/cm^2, 20 mW/cm^2 and 200 mW/cm^2.

1-4.4 Model 8654

Model 8654 Low Frequency Isotropic Probe has a flat frequency response which permits accurate magnetic field equivalent power density measurements over the 300 kHz to 10 MHz frequency range. Model 8654 provides full scale ranges of 20 mW/cm^2, 200 mW/cm^2, and 2000 mW/cm^2.

1-5. EQUIPMENT SUPPLIED

Tables 1-1 and 1-2 tabulate the equipment that is supplied with Models 8616 and 8611 Metering Instruments.

Table 1-1. Equipment Supplied with Model 8616

Model 8616	Broadband Isotropic Radiation Meter
Battery	25 volt nickel cadmium rechargeable
Charging Cable	AC Line Cord
Probe Mount	Model 8630
Shielded Carrying Case	Provides form-fitted cutouts to accomodate meter, three radiation monitor probes and accessories
Manual	Model 8600 Series Operation and Maintenance Manual

Table 1-2. Equipment Supplied with Model 8611

Model 8611	Broadband Isotropic Radiation Meter
Batteries	Two 5.6 volt Mercury NEDA 1404 disposable
Shielded Carrying Case	Provides form-fitted cutouts to accomodate the meter and three radiation monitor probes
Manual	Model 8600 Series Operation and Maintenance Manual

All probes and meters are interchangeable. Available probes are:

Model 8621D	Model 8652	Model 8654
Model 8623D	Model 8661	Model 8660
Model 8631	Model 8662B	
Model 8633	Model 8682	

See Tables 1-3, 1-4, and 1-5, PROBE SPECIFICATIONS, for details.

Table 1-3. PROBE SPECIFICATIONS/Electric Field

Probe Model	8662B	8661	8660	8621D	8623D
Type	ELECTRIC FIELD				
Freq. Ranges	0.3 to 1000 MHz			300 MHz to 40 GHz	
Power Ranges Full Scale (Equivalent Power Density)	2 20 mW/cm² 200	.2 2 mW/cm² 20	.2 2 μW/cm² 20	0.2 2 mW/cm² 20	1 10 mW/cm² 100
Field Strength Full Scale (Mean Squared Field Strength)	8000 V²/m² 80,000 m² 800,000	800 V²/m² 8,000 m² 80,000	.8 V²/m² 8 m² 80	800 V²/m² 8,000 m² 80,000	3800 V²/m² 38,000 m² 380,000
Accuracy of Probe Calibration at Test Frequencies	±0.5 dB				
Isotropic Response	±.5 dB				
Freq. Sensitivity .3 to 10 MHz	–	–	–	–	–
.3 to 300 MHz	±1 .3 dB	±1 .3 dB	±1 dB	–	–
10–300 MHz	±1 dB	±1 dB	–	–	–
13–200 MHz	–	–	–	–	–
.3-1000 MHz	±2 dB	±2 dB	±2 dB	–	–
1-40 GHz	–	–	–	±1.25 dBm	
.85-16 GHz	–	–	–	+75, -1 dB	
.3 to 40 GHz	–	–	–	-3, +1.25 dB	
CW Overload*	600 mW/cm²	60 W/cm²	10 mW/cm²	300 mW/cm²	1000 mW/cm²
Peak Power*	600 W/cm²	60 W/cm²	10 W/cm²	60 W/cm²	300 W/cm²
Calibration Frequencies	0.3, 0.5, 1.0, 3.0, 13.56, 27.12, 40.68, 100, 200, 300, 750, 1000 MHz			0.3, 1.7, 2.45, 4.0, 5.0, 6.0, 7.0, 8.2, 9.3, 10, 11, 18 26, 40 GHz	
Size Probe	17¾" (45cm) Long Including 4" Cup	17¾" (45 cm) Long Including 4" Cup	17¾" (45cm) Long Including 4" Cup	13" (33 cm) Long	
Cable	Four Feet Long (123 cm)				
Use with Meters 8611	X	X	X	X	X
8616	X	X	X	X	X
Operating Temperature Range	0-50 C				

*Operating and Non-Operating
When not in use, store probes in shielded case supplied to avoid accidental exposure to excessive fields

Table 1-4. PROBE SPECIFICATIONS/Model 8682

Probe Type	Electric Field
Frequency Range	300 kHz to 1500 MHz
Full Scale Ranges	2, 20, 200% of RFPG*
Dynamic Range	30 dB
Frequency Response (Equivalent power density required for indication of 100% of RFPG)	300 KHz–3 MHz 100 mW/cm^2 3 MHz–30 MHz $900/f^2$ mW/cm^2 30 MHz–300 MHz 1 mW/cm^2 300 MHz–1500 MHz $f/300$ mW/cm^2 (f is the frequency in MHz)
Relative Frequency Sensitivity	±0.5 dB typical: ±2 dB max
Isotropic Response	±0.5 dB max deviation
Calibration Accuracy	±0.5 dB at calibration frequencies of 0.3, 1.0, 3.0, 13.56, 27.12, 100, 300, 500, 750, 915, 1500 MHz
Pulse Modulation Sensitivity (low duty factors)	+0.75 dB max +0.5 typical**
Operates with Meter Models	8611, 8616
Temperature (operating) (non-operating)	0°C to +50°C -20°C to +60°C

*Radio Frequency Protection Guide contained in ANSI C95.1-1982
**Measured at 001 duty factor (1000:1 peak-to-average ratio)

Table 1-5. PROBE SPECIFICATIONS/Magnetic Field

Probe Model	8652	8654	8631	8633
Type	MAGNETIC FIELD			
Freq. Ranges	0.3 to 10 MHz		10 MHz to 300 MHz	
Power Ranges Full Scale (Equivalent Power Density)	2 20 mW/cm^2 200	20 200 mW/cm^2 2000	0.2 2 mW/cm^2 20	1 10 mW/cm^2 100
Field Strength Full Scale (Mean Squared Field Strength)	.05 $\frac{A^2}{m^2}$ .5 5	0.5 $\frac{A^2}{m^2}$ 5 50	.005 $\frac{A^2}{m^2}$ .05 .5	.026 $\frac{A^2}{m^2}$ .26 2.6
Accuracy of Probe Calibration at Test Frequencies	±0.5 dB			
Isotropic Response	±0.5 dB	±0.75 dB	±0.5 dB	
Freq. Sensitivity .3 to 10 MHz	±0.5 dB	±0.5 dB	–	–
.3 to 300 MHz	–	–	–	–
10–300 MHz	–	–	2 dB Max Total Deviation	
13–200 MHz	–	–	±0.5 dB	
10-3000 MHz	–	–	–	
27-1000 MHz	–	–	–	–
1-12 GHz	–	–	–	–
.85-16 GHz	–	–	–	–
.3 to 26 GHz	–	–	–	–
CW Overload*	600 mW/cm^2	6 W/cm^2	60 mW/cm^2	300 mW/cm^2
Peak Power*	600 W/cm^2	6 KW/cm^2	20 W/cm^2	300 W/cm^2
Calibration Frequencies	0.3, 0.5, 1.3, 10 MHz		10, 13.56, 27.12, 40.68, 50, 75, 100, 150, 200, 200, 300 MHz	
Size Probe	17¼" (43.8 cm) Long Including 4" Cup	17¼" (43.8 cm) Long Including 4" Cup	16½" (41.9 cm) Long Including 3½" Dia Sphere	
Cable	Four Feet Long (123 cm)			
Use with Meters 8611	X	X	X	X
8616	X	X	X	X
Operating Temperature Range	0-50°C			

*Operating and Non-Operating.
When not in use, store probes in shielded case supplied to avoid accidental exposure to excessive fields.

1-6. MODEL 8616 RADIATION METER SPECIFICATIONS (See Table 1-6).

Model 8616 operates with any of the 8600 Series probes. A calibration chart is laminated to the handle of each probe to provide correction factors for a number of frequencies over the operating band.

Table 1-6. MODEL 8616 RADIATION METER SPECIFICATIONS (excluding probes)

Dynamic range	30 dB
Full scale ranges (mW/cm^2)	0-0.2, 0-2, 0-20 and 0-1, 0-10, 0-100; and 0-2, 0-20, 0-200
Accuracy	±3%
Response Time (approx)	1 sec. in fast position 3 sec. in slow position
Recorder Output	+3 v nominal at Full scale into minimum load of 1000Ω
Power Density Alarm	An adjustable audible alarm pre-set by panel control for a percentage of full scale
Battery Type	25 volt rechargeable nickel-cadmium — 40 hours use time 2.5:1 use to charge time

NOTE

Model 8616 Meters with serial numbers below 02001 will require modification for proper operation with 8631 and 8633 probes having serial numbers above 03002.

1-7. MODEL 8611 RADIATION METER SPECIFICATIONS (See Table 1-7).

Model 8611 operates with any of the 8600 Series probes. A calibration chart is laminated to the handle of each probe to provide correction factors for a number of frequencies over the operating band.

Table 1-7. MODEL 8611 RADIATION METER SPECIFICATIONS (excluding probes)

Dynamic range Full scale ranges (mW/cm^2)	30 dB 0-.2, 0-2, 0-20; 0-1, 0-10, 0-100; and 0-2, 0-20, 0-200
Accuracy	±3%
Response Time (approx)	1 second
Battery Type	Two (2) 5.4 volt Mercury batteries. NEDA number 1404
Size	1-3/4" x 4-5/8" x 2-5/8"
Weight	1 pound

NOTE

Models 8631 and 8633 probes must have serial numbers higher than 03001 for proper operation with 8611 Meter.

1-8. MODEL 8699 CHECK SOURCE SPECIFICATIONS

The Model 8699 provides a convenient way of checking microwave probe operability.

Table 1-8. Model 8699 Specifications

Radiation Power	~ 10 mW
Frequency	12 GHz (nominal)

SECTION II
OPERATION

2-1. GENERAL

This section provides the functional control description, operating instructions and precautions for 8600 Series BROADBAND ISOTROPIC RADIATION MONITORS.

2-2. PRELIMINARY INSPECTION

a. This unit was tested and inspected at the factory before shipment. Immediately after unpacking the equipment, visually inspect it for damage which may have occurred in transit. If there is any evidence of damage such as broken knobs, damaged meters, etc., immediately file a claim with the carrier for damage in transit.

b. For Model 8616, the battery should be charged immediately after unpacking. Refer to paragraph 4-26 for proper charging procedure.

c. For Model 8611, the batteries should be installed in the meter, prior to its first use. Refer to paragraph 4-38 for proper procedure for installing batteries.

2-3. MODEL 8616 CONTROL PANEL DESCRIPTION (See Figure 2-1.)

MODEL 8616 FRONT PANEL. Table 2-1 provides a complete functional description of all front panel controls and indicators.

2-4. MODEL 8611 CONTROL PANEL DESCRIPTION (See Figure 2-2.)

MODEL 8611 FRONT PANEL. Table 2-2 provides Front Panel Control and Indicator Functional Description.

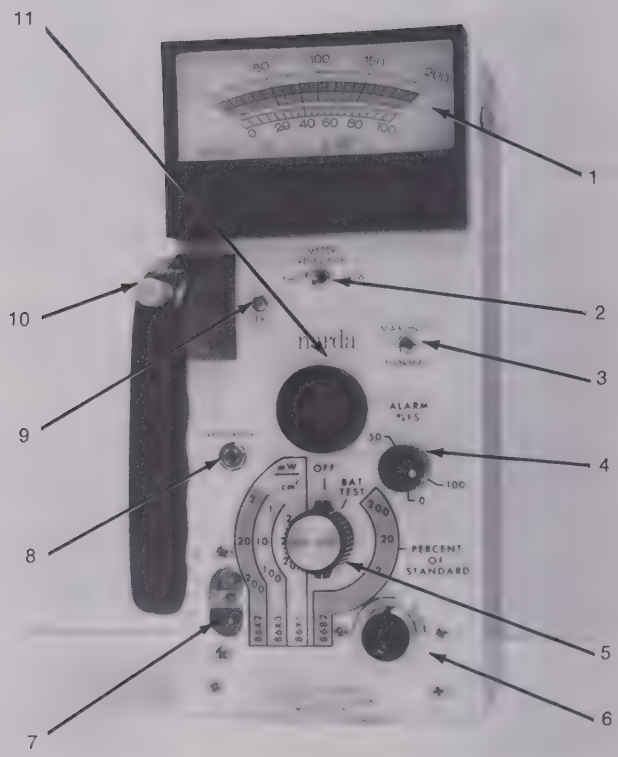


Figure 2-1. Model 8616 front panel.

Table 2-1. Model 8616 Front Panel Control and Indicator Functional Description (See Figure 2-1.)

Index No.	Control	Function
1	Meter	Indicates the level of the r-f field in mW/cm^2 as sensed by the Isotropic Probe (Refer to Tables 1-3, 1-4, and 1-5 for specifications.)
2	METER RESPONSE Switch	Provides means of selecting FAST or SLOW meter response.
3	MODE Switch	Selects either normal operation or Maximum Hold mode.
4	ALARM Control	Provides means of setting the percentage of full scale meter reading at which the audio alarm will sound to alert the operator of power density greater than the preset level.
5	RANGE Switch	Provides means of selecting either mW/cm^2 or percent of standard.
6	Probe Connector	Provides for connection of Isotropic Probe.
7	AC Cable Plug Connector	Provides for connection to 115/230 vac electrical power for battery charging.
8	RECORDER Jack	Provides for the connection of an external recorder. Provides 3 volts full scale.
9	ZERO Control	Provides for electrical adjustment of meter zero setting.
10	ZERO Button	Provides for automatic electrical setting of meter.
11	Alarm	Provides audio alarm to indicate when the preset power density level is exceeded.

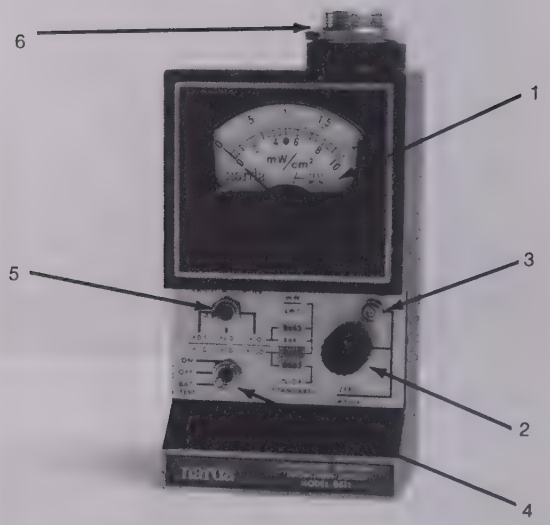


Figure 2-2. Model 8611 front panel.

Table 2-2. Model 8611 Front Panel Control and Indicator Functional Description (See Figure 2-2.)

Index No.	Control	Function
1	Meter	Indicates the level of the r-f field in mW/cm^2 as sensed by the Isotropic Probe (Refer to Tables 1-3, 1-4, and 1-5 for specifications.)
2	ZERO Control	Provides for fine electrical adjustment of meter zero setting
3	Coarse Zero Potentiometer	Provides for coarse electrical adjustment of meter zero setting
4	BAT TEST-ON-OFF Switch	a. BAT TEST position — provides means of testing batteries b. ON-OFF position — provides means of turning operating voltages on or off
5	RANGE MULTI-Switch	Provides means of selecting either the X.1, X1 or X10 sensitivity range
6	Probe Connector	Provides for connection of Isotropic Probe

2-5. GENERAL OPERATING INFORMATION

If the Isotropic Probe is very close to the radiating source, it should be oriented with the axis of the handle in line with the direction of travel of the suspected radiation (probe pointing towards the source).

Narda probes are calibrated in a free space plane wave. The Models 8621 and 8623 high frequency probes cover the range of 0.3 to 40 GHz and measure the "E" (electric) field. Models 8631 and 8633 low frequency probes cover the range of 10 MHz to 300 MHz and Five additional low frequency probes, Model 8652, 8654, 8660, 8661 and 8662B are available. These probes will extend the frequency range of the system down to 300 kHz. The Models 8652 and 8654 measure the magnetic field and cover the frequency range of the system up to 10 MHz. The Models 8660, 8661 and 8662B measure the electric field and cover the frequency range from 300 kHz to 1000 MHz. The full scale equivalent power density for Models 8652 and 8662B is 200 mW/cm^2. The full scale equivalent power density for the Model 8661 is 20 mW/cm^2. The full scale equivalent power density for the Model 8654 is 2000 mW/cm^2.

The Model 8682 electric field ANSI conformal probe has a frequency range of 0.3 MHz through 1500 MHz with a sensitivity characteristic that is the reverse of the C95.1-1982 ANSI Radio Frequency Protection Guide. Metering when this probe is used with the 8616 is in percent of the Standard. The range decal and selector knob permit proper scaling at 200%, 20% and 2% full scale of the Standard.

CAUTION

Overload levels for Peak and CW signals are given in Tables 1-3, 1-4, 1-5; to prevent damage to the probes these levels should not be exceeded.

The meter scales are marked in power density and truly apply in free space conditions where the ratio of the electric and the magnetic field is 377 ohms. At present, most specifications for radiation hazards use equivalent plane wave power density of mW/cm^2. Narda probes are therefore calibrated for meter reading in mW/cm^2 although they measure the electric and magnetic field components.

Table 2-3 is a conversion table for meter readings in mW/cm^2 to quantities in field strength squared, energy density, and power density in SI units, Watts/Meter^2. Table 2-4 is a conversion table from Power Density to Field Strength. Figures 2-3 and 2-4 are graphic charts of the field strength conversion. Table 2-5 lists the equations to make all necessary conversions.

NOTE

Calibration data is provided to specify correction factors for each probe at a number of frequencies over its operating band. This calibration data is laminated on the probe handle.

WARNING

MODEL 8631, 8633, 8652 AND 8654 ISOTROPIC PROBES MAY PRODUCE ERRONEOUS READINGS IN RESPONSE TO OUT OF BAND SIGNALS ABOVE 300 MHz FOR 8631, 8633 AND 10 MHz FOR MODELS 8652 AND 8654.

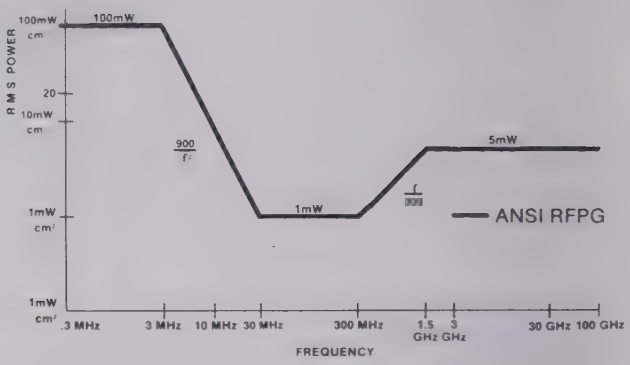
NOTE

The ANSI Radio Frequency Protection Guide (C95.1-1982) covers the recommended levels for the 300 kHz to 100 GHz range. A summary of the standard is included below for informational purposes.

Radiofrequency Protection Guides

Frequency Range	Power Density	E^2	H^2
MHz	mW/cm^2	V^2/m^2	A^2/m^2
0.3 – 3	100	400,000	2.5
3 – 30	$900/f^2$	4,000 ($900/f^2$)	0.025 ($900/f^2$)
30 – 300	1.0	4,000	0.025
300 – 1500	f/300	4,000 (f/300)	0.025 (f/300)
1500 – 100,000	5	20,000	0.125

Note: f is the frequency, in MHz. Below 300 MHz, both E and H fields must be measured independently.



NOTE

Whole body exposure averaged over 0.1 hours. Both electric and magnetic fields must be measured separately for near field exposure. For mixed or broadband fields consisting of a number of frequencies for which there are different values of the RFPG, the fraction of the RFPG incurred within each frequency interval shall be determined, and the sum of all such fractions shall not exceed unity.

Figure 2-3. Power Density to Electric Field Strength

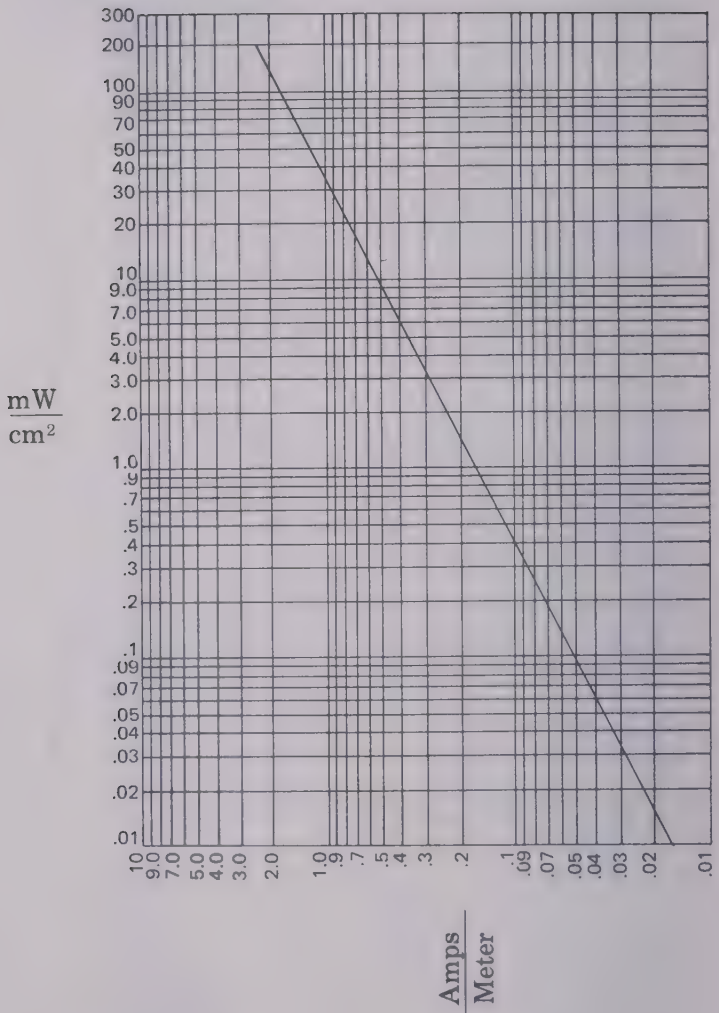


Figure 2-4. Power Density to Magnetic Field Strength

Table 2-3. Power Density Conversion Table

mW/cm^2	$\frac{E^2}{m^2}$	$\frac{A^2}{m^2}$	$\frac{*pJ}{cm^3}$	$\frac{watt}{m^2}$
	$\frac{(volts)^2}{(meter)^2}$	$\frac{(ampere)^2}{(meter)^2}$	$\frac{pico\ Joules}{cm^3}$	$\frac{watts}{Meter^2}$
Power Density	Mean squared Electric Field Strength	Mean squared Magnetic Field Strength	Total Energy Density	Power Density
100	376360	2.657	3.333	1000
50	188180	1.328	1.666	500
20	75272	.5314	.6666	200
10	37636	.2657	.3333	100
5	18818	.1328	.1666	50
2	7527.2	.05314	.06666	20
1	3763.6	.02657	.03333	10
.5	1881.8	.01328	.01666	5
.2	752.72	.005314	.006666	2
.1	376.36	.002657	.003333	1
.05	188.18	.001328	.001666	.5
.02	75.272	.0005314	.0006666	.2
.01	37.636	.0002657	.0003333	.1

*pJ/cm^3 = I$\mu J/m^3$

Table 2-4. Conversion of Power Density (Free Space) to Field Strength

Power Density mW/cm^2	Electric Field Strength Volts/meter	Magnetic Field Strength Amperes/meter
100	613.5	1.630
50	433.8	1.152
20	274	.7290
10	194	.5155
5	137	.3644
2	86.7	.2305
1	61.3	.1630
.5	43.4	.1152
.2	27.4	.0729
.1	19.4	.0515
.05	13.7	.0364
.02	8.67	.0230
.01	6.13	.0163

Table 2-5. Conversion of Power Density in mW/cm^2 to other Parameters based upon Free Space Conditions

$mW/cm^2 \times 10 = \frac{Watts}{(meter)^2} = \frac{W}{(M)^2}$; power density

$mW/cm^2 \times 3763.6 = \frac{(Volt)^2}{(Meter)^2} = \frac{(E)^2}{(M)^2}$;Mean squared Electric Field Strength

$mW/cm^2 \div 37.636 = \frac{(Amperes)^2}{(Meter)^2} = \frac{(A)^2}{(M)^2}$;Mean squared Magnetic Field Strength

$mW/cm^2 \times .03333 = \frac{Pico\ Joules}{(cm)^3} = pJ/cm^2$;Energy Density *

$\sqrt{mW/cm^2 \times 3763.6} = \frac{Volts}{Meter} = \frac{E}{M}$;Electric Field Strength

$\sqrt{mW/cm^2 \div 37.636} = \frac{Amperes}{Meter} = \frac{A}{M}$;Magnetic Field Strength

* $1\ pJ/cm^3 = 1\ uJ/m^3$

2-6. FULL SCALE RANGES

Model 8662B Electric Field Probes and Model 8652 Magnetic Field Probes both have full scale ranges of 2, 20, and 200 mW/cm^2. Model 8682 ANSI Conformal Probes have full scale ranges of 2, 20, and 200% of the C95.1-1982 Radio Frequency Protection Guide.

In expanding our product line, we have maintained the practice of color coding probes by power range. Those 8600 Series probes with a last digit of "1" (8621, 8631) and full scale ranges of 0.2, 2, and 20 mW/cm^2 continue to be white in color. The range switch scale background color and color of the meter face scale for use with these probes remain white.

Those 8600 series probes with a last digit of "3" (8623, 8633) and full scale ranges of 1, 10, and 100 mW/cm^2 continue to be yellow in color. The range switch scale color, which had been yellow on a black background, will now have a yellow background; the color of the meter face scale for use with these probes remains yellow.

The 8600 series probes with a last digit of "2" (8662B, 8652) and full scale ranges of 2, 20, and 200 mW/cm^2 are color-coded tan. The background color for the range switch scale for use with these probes is tan; the meter face also includes a scale range keyed to the tan color.

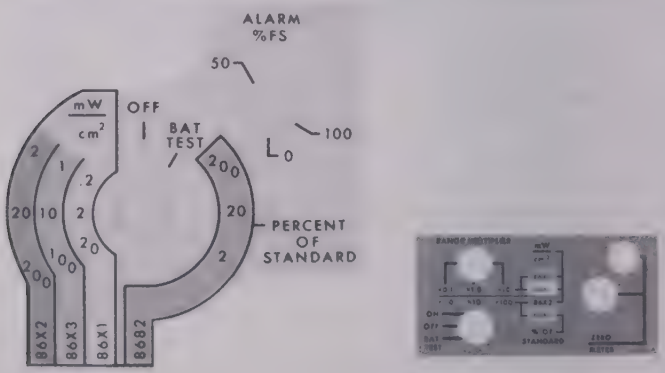


Figure 2-5. Meter faces are designed with color-coded decals that group probes by power range.

These scales are marked to indicate the model series to which they apply: 86X1, 86X3, 86X2 respectively. For example, 86X3 applies to both the 8623 and 8633 probes, and would be used for any future probes with a 100 mW/cm^2 upper limit (and model number ending in the digit "3").

Model 8682 is color-coded blue, and the background color of the range switch scale labeled "2, 20, and 200 Percent of Standard" is blue in color.

This expanded color coding scheme is being implemented on all new Model meters. Kits to convert existing meters (including self-adhesive colored decal, new range selector knob, and the necessary tools) are enclosed with Model 8652, 8662, and 8682 probes. Additional kits are available upon request. (Please supply meter serial number.) These decals are also being applied to all meters received for routine recalibration.

2-7. PRE-OPERATION — MODEL 8616 METER

CAUTION

Do not open case containing probes in an area where a high field may exist. See overload data in Table 1-4.

The following procedures should be performed before operating Models 8600 Series Broadband Isotropic Radiation Monitors with Model 8616 Meter.

a. Review all safety procedures before beginning a radiation survey.

b. Connect the desired Isotropic Probe to the meter by plugging the probe cable into the connector and tightening the locking collar.

c. Set the METER RESPONSE switch to the FAST position.

d. Set the ALARM control to the 100% position.

e. Set the MODE switch to the NORMAL position.

f. Set the RANGE switch to the BAT TEST position. Observe the meter indication; it should read

above the TEST MIN mark on the meter face. If the meter reads below TEST MIN, connect charging line cord and recharge battery. Use to charge ratio is 2.5:1. Every 1 hour of charge time will allow 2.5 hours of use and a fully charged battery will therefore permit a minimum of 40 hours of use time. Sixteen hours of charge time will insure a fully charged battery. Model 8616 may be charged indefinitely without any danger of damage to either the battery or meter.

CAUTION

The required charging power source voltage is indicated at the front panel line cord connector. It will indicate 115 or 230. This must correspond to the line source voltage. An internal charging switch may be reset to accomodate the available source.

g. Set range switch to 20/100/200 mW/cm^2 position.

h. Depress the ZERO pushbutton and hold for a "0" reading on the meter scale.

NOTE

When zeroing the meter, the Isotropic Probe should be placed in a zero density area to avoid stray power density pickup. If zero density area is not available, place the probe in the carrying case and partially close the cover when zeroing.

WARNING

IF METER CANNOT BE ZEROED, THE ISOTROPIC PROBE MAY BE DEFECTIVE. DO NOT USE A DEFECTIVE PROBE TO MEASURE POTENTIALLY HAZARDOUS RADIATION AREAS.

i. Set the RANGE switch to the 2/10/20 mW/cm^2 position and press ZERO button for a "0" reading on meter scale.

j. Repeat ZERO operation (step i) on the 2/1/2 mW/cm^2 scale.

k. Reset ALARM control to the desired threshold value.

l. Probe operation may be checked by using Model 8699 Test Source. Depress switch on 8699 for generation of test field.

2-8. PRE-OPERATION, MODEL 8611 METER

The following procedures should be performed before operating Model 8600 Series Broadband Isotropic Radiation Monitors with 8611 Meter.

a. Review all safety procedures before beginning a radiation survey.

CAUTION

DO NOT OPEN CASE CONTAINING PROBES IN AN AREA WHERE A HIGH FIELD MAY EXIST. SEE OVERLOAD DATA IN TABLE 1-4.

WARNING

DO NOT PLACE THE EYES IN DIRECT LINE WITH A SUSPECTED SOURCE OF MICROWAVE ENERGY.

b. Set the BAT TEST-ON-OFF switch to the BAT TEST position. Observe the meter indication; it should read above the TEST MIN mark on the meter face.

NOTE

If the meter indication is below the TEST MIN mark, the battery should be replaced. Refer to paragraph 4-38 for proper battery replacement procedure.

c. Connect the desired isotropic probe to the meter by plugging the probe cable into the connector on top of unit and tightening the locking collar.

d. Set the RANGE MULTIPLIER switch to the X.1 position.

e. Set the BAT TEST-ON-OFF switch to the ON position.

NOTE

Allow minimum warm up time of 5 minutes.

f. Adjust the ZERO control for a zero indication.

NOTE

When zeroing the meter, the Isotropic Probe should be placed in a zero density area to avoid stray power density pickup. If zero density area is not available, place the probe in the carrying case and partially close the cover when zeroing.

WARNING

IF METER CANNOT BE ZEROED, THE ISOTROPIC PROBE MAY BE DEFECTIVE. DO NOT USE A DEFECTIVE PROBE TO MEASURE POTENTIALLY HAZARDOUS RADIATION AREAS.

g. Slowly introduce the isotropic probe into the unknown field. Hold the probe by its handle and point it toward the unit under test, the meter should be held away from the suspected radiating source. Move the probe in a circular motion around the suspected area of radiation leakage. Observe the meter reading. If the meter indication approaches full scale, withdraw the isotropic probe and set the RANGE MULTIPLIER switch to the X1.0 position.

CAUTION

OBSERVE THAT METER READING DOES NOT EXCEED FULL SCALE DEFLECTION.

NOTE

To ensure maximum accuracy of meter reading, the probe should be rotated about its axis and the average minimum and maximum readings obtained.

2-9. PEAK POWER RATINGS

CAUTION

Operating and Non-Operating. When not in use, store probes in shielded case supplied to avoid accidental exposure to excessive fields.

The maximum peak power rating of Models 8621, 8661, and 8631 Isotropic Probes is 60 W/cm^2. The peak power ratings of Models 8623 and 8633 is 300 W/cm^2 and 600 W/cm^2 for Models 8652 and 8662B.

When using Models 8621, 8661, and 8631 Isotropic Probes to make measurements where radar duty factors are less than 0.00033, the full scale meter indication will exceed the 60 W/cm^2 maximum peak power density.

The maximum average power density indication with Models 8621 and 8631 Probes is equal to 60 W/cm^2 times the duty factor and with Models 8623 and 8633 Probes is equal to 300 W/cm^2 times the duty factor.

The nomograph on the next page may be used to determine the maximum average power density indication that corresponds to the peak power ratings of 60 W/cm^2 and 300 W/cm^2, as follows:

The intersection of the duty factor line with the 60 W/cm^2 (heavy solid vertical) line for Model 8621, 8661 and 8631 Probes, or the intersection of the duty factor line with the 300 W/cm^2 (heavy broken vertical) line for the Models 8623 and 8633 Probes, determines maximum average indicated power density. From the chart, the radar duty factors can be determined for the peak power density ratings of the probe.

The duty factor is the product of the Pulse Width and Pulse Repetition Frequency and may be determined by locating the intersection of the Pulse Repetition Frequency and Pulse Width lines. Refer to Figure 2-6.

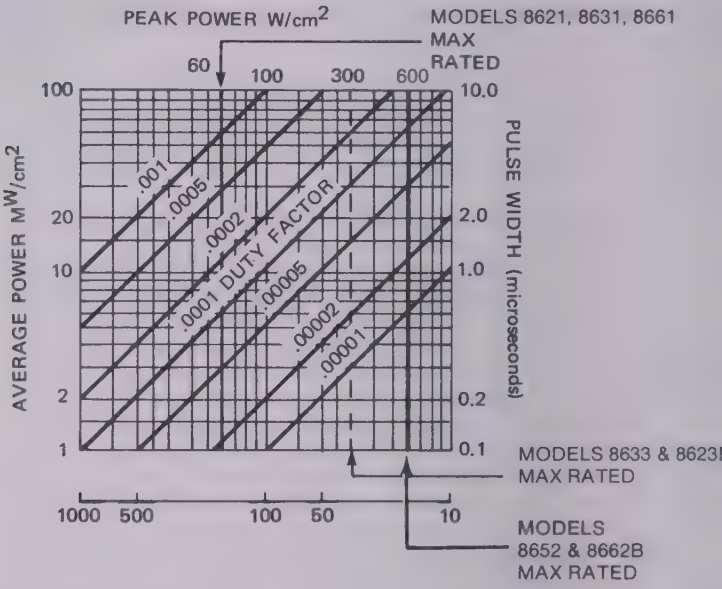
NOTE

It may be necessary to interpolate between adjacent duty factor lines.

2-10. STATIC CHARGED AREAS

Although the Isotropic Probe is equipped with a static charge shield, some meter deflection may be

observed on the most sensitive scale when the probe is in motion in a high static charged area. This phenomena will not affect instrument accuracy. Accurate readings will be obtained when the probe is held motionless.



MAXIMUM ALLOWABLE
CW METER READINGS

F EMITTER DUTY CYCLE P.W. x P.R.F.) is:	MODELS 8633, 8623 YELLOW COLOR 100 mW/cm² 300 WATTS PEAK DO NOT EXCEED METER READINGS BELOW (X10 SCALE)	MODELS 8631, 8621 WHITE COLOR 20 mW/cm² 60 WATTS PEAK DO NOT EXCEED METER READINGS BELOW (X10 SCALE)	MODEL 8662 8652 PROBES 200 mW/cm² 600 WATTS PEAK DO NOT EXCEED METER READINGS BELOW (X10 SCALE)
.00015 TO .00019	45 mW/cm²	9 mW/cm²	90
0002 TO .00024	60	12	120
00025 TO .00029	75	15	150
.00030 TO .00033	90	18	180
00034 TO C.W.	FULL SCALE	FULL SCALE	FULL SCALE

Figure 2-6. Maximum Peak Power Density Nomograph

2-11. ZERO DRIFT

To minimize zero drift, allow approximately fifteen minutes of warm up time when operating the meter on the most sensitive range.

2-12. OPERATING PROCEDURE

a. Perform Pre-Operating Procedures (paragraph 2-7 or 2-8) before attempting a radiation survey.

b. Always start to measure an unknown field as far from the source as possible. This will insure the safety of operating personnel.

c. Slowly introduce the isotropic probe into the unknown field. Hold the probe by its handle and point it toward the unit under test or radiating source. THE METER SHOULD BE HELD AWAY FROM THE SOURCE. Move the probe in a circular motion in the area of the radiation field. If location or direction of propagation is not known, the probe axis is best held at 45° to the ground (or horizontal surface) arm outstretched. Observe the meter reading. If the meter indication approaches full scale, withdraw the isotropic probe and set the RANGE switch to the 2/10/20 W/cm² position. If the meter indication approaches full scale, withdraw the Isotropic Probe and set the range switch to the 20/100/200 position.

d. To insure maximum accuracy of meter reading, the probe should be rotated about its axis and the average of minimum and maximum readings obtained.

e. If the approximate power density of the field to be measured is not known, use the probe that has the highest power rating available.

WARNING

DO NOT ENTER A SUSPECTED RADIATION FIELD UNTIL A SAFE DENSITY LEVEL HAS BEEN ASCERTAINED! (REFER TO MAXIMUM PERMISSABLE EXPOSURE GUIDE IN USE.)

2-13. REMOTE OPERATION (8616)

a. Radiation measurements can be made without the need for personnel in the radiation field by use of the recorder output.

b. The recorder output provides a nominal 3 volt signal at full scale into a minimum load of 1000Ω.

c. Access to this recorder output is made through the miniature phone jack on the front panel. A shielded cable should be used to connect this recorder output to a recorder or indicating meter.

d. The recorder output is directly proportional to the meter indications. Calibration can be accomplished through use of potentiometer or gain control on a high impedance meter. The load resistance must be greater than 1000Ω. For power conservation, a value of 3000 or 10,000Ω would be more desirable.

e. When used with a current operated indicator or recorder, a series resistor may be used to calibrate the remote indicator. Again, the load impedance must be greater than 1000Ω.

f. If the remote indicating equipment will be in the radiation field, this equipment should be shielded to insure proper operation. Position the cable normal to the "E" field to minimize perturbation of the field.

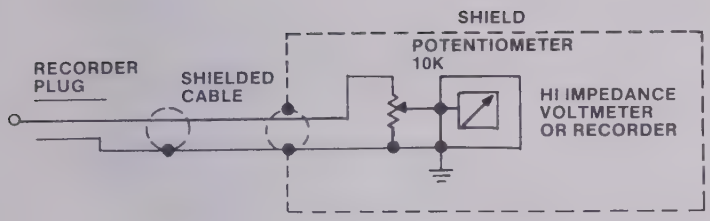


Figure 2-7. Remote Voltage Operated Indicator

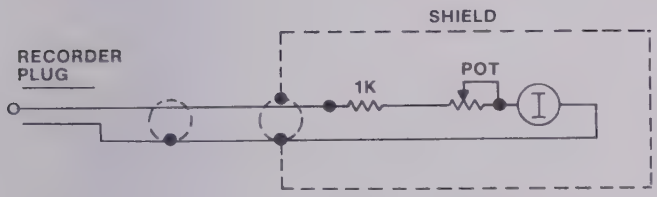


Figure 2-8. Remote Current Operated Indicator

2-14. AC OPERATION

Model 8616 Meter may be operated continuously from a 115 or 230 volt, 50 to 440 Hz power line.

The proper required voltage is indicated at the front panel AC Charge connector. If possible, the line cord should be kept out of the radiation field. If this is not possible, the cable should be oriented so that it is normal to the "E" electric field.

To change the required line voltage from one setting to the other, proceed as follows:

a. Remove cover from unit by removing six screws at back of case.

b. Set the 115/230 VAC Switch to the desired position.

c. Loosen two screws holding AC INPUT CONNECTOR. Place "Flag" over appropriate panel markings to indicate proper line voltage.

d. Connect the Charging Cable to the AC power Source.

2-15. MAX HOLD MODE OF OPERATION (8616)

With the MODE switch in the MAX HOLD position, the meter will indicate and retain the maximum value of power density that the probe has surveyed. This reading will be retained until the ZERO pushbutton is depressed. The drift rate for the MAX HOLD Mode is less than 0.3% of reading per minute. A MAX HOLD reading will be retained within 3% of its initial value after 10 minutes of elapsed time.

The recorder output corresponds to the meter indications and provides a retained output voltage of 3 volts ± 10% at full scale meter indication. The recorder output will operate into a minimum load resistance of 1 KΩ. The audible alarm continues to operate in its normal mode and will sound only during the period that the alarm threshold is exceeded. All of the preceding procedures are the same except that the mode switch is in the MAX HOLD rather than the NORMAL position.

It is NOT recommended that the meter be operated in MAX HOLD when the Meter Response switch is set to "Slow".

2-16. METER RESPONSE SELECTION (8616)

A front panel selector switch permits operation of the meter with a fast or slow response. In the SLOW position the meter will indicate 90% of the full value of a field having a step function characteristic in approximately 3 seconds. This integrating characteristic may be used to average time varying fields. In the FAST position, the meter responds to a step function field in less than 1 second. The FAST position is recommended for all except the most unusual situations.

SECTION III

THEORY OF OPERATION

3-1. GENERAL

This section provides a brief description of the major circuits of Narda Broadband Isotropic Radiation Monitors. Figure 3-1 is a simplified block diagram showing the principal circuits. Each circuit section and major individual circuits are explained.

As illustrated in Figure 3-1, the probes consist of the sensing element and a pre-amplifier with Variable Gain. The meter consists of a Decade Adjustable Feedback Circuit, Indicator and Battery Circuits, and Auto Zero and Max Hold Circuits in the Model 8616.

The electromagnetic field being surveyed induces current in the thermoelectric elements in the probe. A low level DC thermoelectric voltage is generated and transmitted by resistive leads to the variable gain pre-amplifier. The gain setting of this pre-amplifier establishes the calibration of the probe and the output of the pre-amplifier is connected by cable to the meter.

Model 8616 comprises a decade adjustable amplifier, U2, which drives both an alarm section and indicator circuits. The alarm section consists of a comparator, U3, with a front panel adjustable threshold, a driver transistor, Q5, and audible alarm, G1. The indicator circuits (U4, U5) provide a normal instantaneous indication or a maximum hold mode, which reads and retains the maximum signals supplied to the indicator.

In this mode the meter indicates the maximum power density surveyed. Operation of the ZERO pushbutton resets the circuits and activates the auto zero circuits in both normal and maximum hold modes of operation. These circuits utilize U1, Q1, and Q2 to sense the meter zero offset and supply a correction voltage to the input of the pre-amplifier.

The Model 8611 (Figure 3-6) comprises a decade adjustable feedback circuit and indicator circuits. By front panel selection of the RANGE switch, the gain of

Figure 3-1. Simplified Block Diagram

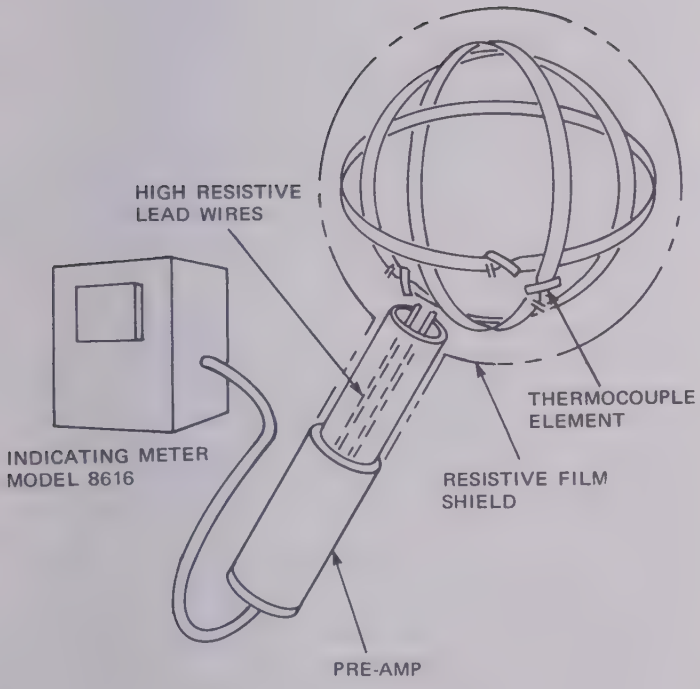


Figure 3-2. Low Frequency System Portrayal

the probe amplifier is changed in decade steps. An internal potentiometer is set to provide the required indicator meter accuracy. The ZERO control potentiometer provides a fine meter adjustment.

3-2. BATTERY TEST (8616)

The battery test circuit ensures that the battery meets minimum operating requirements. When front panel TEST switch S101 is set to BAT, front panel meter M101 functions as a voltmeter and samples the battery voltage. A fully charged battery will provide a minimum of 40 hours of continuous use without recharge. The use to charge ratio is 2.5:1 and a charge period of 1 hour is therefore required for every 2.5 hours of use. Extended life of the battery will be obtained by maintaining a fairly charged condition. Test indications should be read above the "Test Min" mark.

3-3. BATTERY TEST (8611)

The battery test circuit permits the testing of the battery to ensure that it meets the minimum operating requirements. When the front panel TEST switch S101 is in the BAT position, the front panel meter M101 functions as a voltmeter and samples the battery voltage. A fully charged battery will provide a minimum of 500 hours of continuous use without replacement.

3-4. MAGNETIC FIELD PROBES: MODELS 8631, 8633, 8652, AND 8654

Models 8631 and 8633 are low frequency probes covering the range of 10 MHz to 300 MHz. The power density range of the 8631 is 20 mW/cm^2 maximum and the 8633 is 100 mW/cm^2 maximum full scale. The dynamic range for both probes is 30 dB below their full scale values; 20 mW/cm^2 to 20 $\mu W/cm^2$ for the 8631 and 100 mW/cm^2 to 100 $\mu W/cm^2$ for the 8633. Both probes are isotropic, and independent of polarization. They have true square law characteristics providing an accurate summation of power density present from multiple frequency sources. The Models 8652 and 8654 cover the range of 0.3 MHz to 10 MHz. The power density range for the 8652 is 200 mW/cm^2 maximum full scale. The dynamic range is 30 dB below the full scale value: 200 mW/cm^2 to 200 $\mu W/cm^2$.

The probes are responsive to the "H" field. Each of the three mutually perpendicular coils in every probe has a diameter of 3.5 inches (8.9 cm) consists of multiple turns and is series resonated somewhat below the low frequency end of the band. Each coil is terminated with a thin film thermocouple element with a resistance of 30 Ω for the 8631, 8633 probes and 300 Ω for the Model 8652 and 8654 probes.

A lumped equivalent circuit of a coil is shown in Figure 3-3. "C" is the lumped resonating capacitor, "L" is the inductance of each turn (each turn is effectively shunted by its loop capacitance) and "R_r" is the radiation resistance. Both the latter capacitance and the radiation resistance are extremely small and are negligable in the operating band. "R" is the resistance of the thin film thermocouple element and "e" is the induced equivalent open circuit voltage.

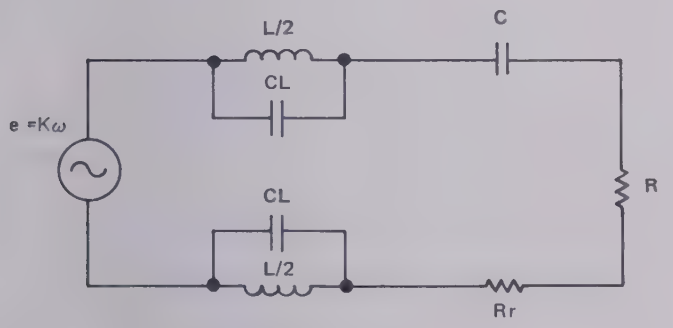


Figure 3-3. Models 8631, 8633, 8652 and 8654 Lumped Equivalent Circuit

Very high resistance monolithic leads interconnect the thermocouple elements in series and provide connection to the pre-amplifier in the probe handle.

The RF current induced by the "H" field dissipates power in the thermocouple elements, heats the hot

junctions and provides a DC output voltage proportional to the square of the induced current.

The frequency sensitivity of the probe is flat to within ±0.5dB from 13 MHz to 200 MHz and exhibits an additional deviation in sensitivity of about 0.5dB between 200 and 300 MHz. This increase is because the probe has now become responsive to the "E" field. The Model 8652 is flat to ±0.5 dB from 0.3 to 10 MHz.

The pre-amplifier is connected to the elements by inflexible monolithic leads. This prevents the cable from modulating the signal if it is flexed or moved. The pre-amplifier, an extremely low noise operational amplifier with a minimum of zero offset characteristic, establishes the calibration of the probe.

A multiconductor shielded cable connects the pre-amp probe to the meter. This cable carries the pre-amp output, the power supply voltages and a correction voltage which is applied to the input of the amplifier to compensate for the zero offset. The cable disconnects at the Model 8616 front panel.

The entire probe is covered with a thin film, high resistive coating. This film is in the order of 0.5 megohm per square inch and provides a shield against electrostatic charges.

Complete interchangeability exists between any and all 8600 Series Probes and Models 8616 or 8611 Meters.

3-5. ELECTRIC FIELD PROBES: Models 8621, 8623, 8661, 8662B and 8682

Models 8621 and 8623 are high frequency probes which cover the range of 300 MHz to 40 GHz.

The power density range of the 8621 is 20 mW/cm^2 maximum and the 8623 is 100 $\mu W/cm^2$ maximum full scale. The dynamic range for both probes is 30 dB below their full scale values, i.e., 20 $\mu W/cm^2$ to 20 mW/cm^2 for the 8621, 100 $\mu W/cm^2$ to 100 mW/cm^2 for the 8623.

Both probes are isotropic and independent of polarization. They exhibit true square law characteristics to provide an accurate summation of

power density present from multiple frequency sources. Both units are responsive to the "E" field.

Each probe contains three mutually perpendicular lossy probe elements and provides a DC output signal proportional to the square of the electric field strength tangential to the element. The summation of the DC signals (from the three orthogonal probe elements) provides a measure of the total energy, or power density, independent of direction or polarization of the RF signals. Detectors for DC signal generation are thin-film thermocouples that provide true square-law output. The DC signal is proportional to the power dissipated in the thermocouple elements and the average energy density in the volume in which the elements are contained.

The pre-amplifier is located in the handle and connected to the elements by inflexible monolithic leads. This prevents the cable from modulating the signal if it is flexed or moved.

The pre-amplifier, an extremely low noise operational amplifier with a minimum of zero offset characteristic, establishes the calibration of the probe.

A multiconductor shielded cable connects the pre-amp probe to the 8616 meter. This cable carries the pre-amp output, the power supply voltages and a correction voltage which is applied to the input of the amplifier to compensate for the zero offset. The cable disconnects at the meter front panel.

The probe's broadband characteristics are obtained by distributing resistive thermocouple dipoles along the length of the element at spacings that will permit no resonant lengths over the range of frequencies within which the probe is intended to operate. The spacing is less than $1/4\lambda$ of the highest frequency to be measured. The probe may be viewed as a group of series-connected, small resistive dipoles or as a very low Q resonant circuit.

A lumped equivalent schematic representation of a probe element is shown in Figure 3-5. R2 and C2 represent a terminal load of one of the probe elements (center-fed dipoles) and L1, C1 are the lumped

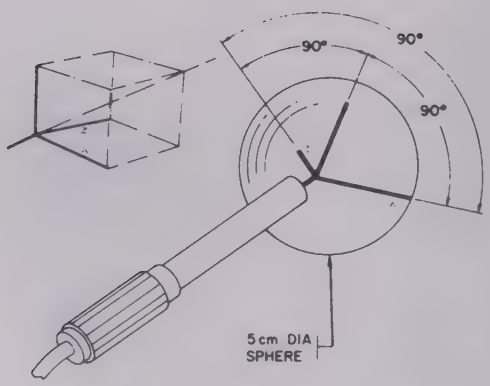


Figure 3-4. Relationship of the three mutually orthogonal probe elements. Probe elements are contained within a 5 cm sphere

equivalent inductance and capacitance of the probe element determined from the average characteristic impedance Z_0.

The entire probe is covered with a thin film, high resistive coating. This film is in the order of 0.5 megohm per square inch and provides a shield against electrostatic charges.

Models 8661 and 8662B are similar to the 8621 and 8623 probes with the exception that the sensors are conductive dipoles terminated in diode detectors. The broad bandwidth is achieved through the capacitive divider effect of the dipole-diode combination. Some linearity correction is also provided for the upper portion of the high power density scale.

3-6. 8682 PROBE DESCRIPTION

The 0.3 MHz to 1.5 GHz Electromagnetic Radiation Probe Model 8682 provides a frequency versus sensitivity characteristic that is the inverse of the C95.1-1982 ANSI standard radio frequency protection guide, thus providing for metering in percent of exposure limit. The shaping and broadband range is accomplished using unique detector circuitry.

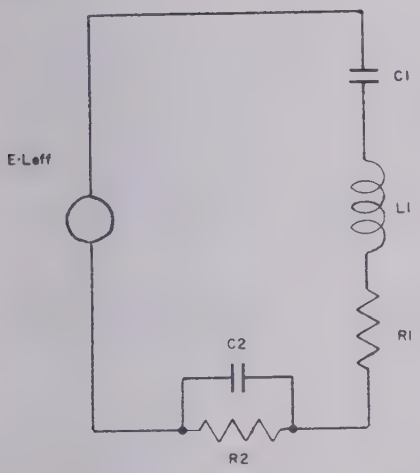


Figure 3-5. Lumped equivalent circuit of the probe with single elements relative to the total probe. R2 represents one of the distributed thermocouples

3-6.1 Element Description

Over the 0.3 MHz to 1500 MHz range of this probe, the sensitivity varies by 20 dB, a dipole with diode detector and both distributed and discrete components are used to shape the frequency response.

Three sensors are supported at one end of the probe along mutually orthogonal axes, each sensor consisting of a dipole-diode combination. Each diode is shunted with circuitry to modify the frequency response to the induced signals so that the DC voltage output of the probe is proportional to the exposure level.

The resistive transmission line carries the modified signals to the metering circuits. These metering circuits include a pre-amplifier to condition the signals prior to transmission over the flexible cable for display on the metering instrument. The pre-amplifier contains the controls for calibration.

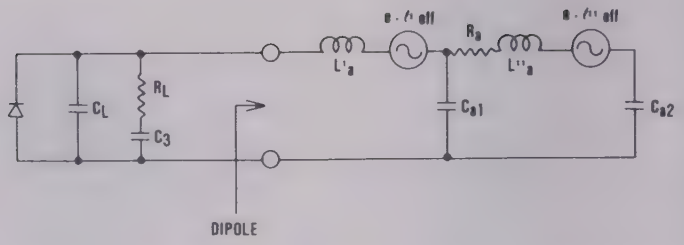


Figure 3-6. Lumped equivalent circuit of dipole-diode sensors

The conditioning amplifier lowers the impedance of the signals, preventing cable modulation by the flexible cable and also provides automatic zero control. The pre-amplifier is a true differential amplifier contributing good common rejection thereby reducing the susceptability to static charges. To further enhance this characteristic, a high resistance film covers the probe surface. The resistance is sufficiently high as to appear transparent to the radio frequency signal while providing a discharge path for static charges.

A lumped equivalent circuit of a dipole-diode sensor is shown in Figure 3-6. The segments illustrated separately as "Ca1", "Ca2", "La1", "La2", represent the dipole equivalent capacitance and inductance. When considering the combined effect of such reactances, they will be referred to as "Ca" and "La". Similarly, the voltage induced in the dipole by the illuminating energy is represented by separate sources "e". The equivalent resistance of the dipole is "Ra". Note that the dipole is constructed of conductive and resistive segments.

In the frequency range of 30 to 300 MHz, the equivalent circuit simplifies to that of Figure 3-7.

The dipole resistance "Ra" and dipole inductive reactance of "La" are negligible compared to the dipole capacitive reactance "Ca". Within this range, "C2" is selected to have a very low reactance and the resistance of "R2" is selected to be extremely high relative to the reactance of shunting capacitor "C1". The dipole

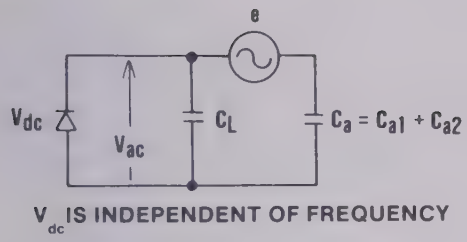


Figure 3-7. Equivalent circuit for 30 to 1000 MHz.

capacitance "Ca" and the shunting capacitance "C1" act as a capacitive voltage divider having a uniform output with frequency over this range. The value of "C1" is selected to obtain the desired sensitivity from the diode.

Descending in frequency and commencing at 30 MHz, the shape of the response is principally controlled by the resistance "R2" in conjunction with the reactance of shunting capacitor "C1" and dipole capacitance "Ca".

The equivalent circuit then reduces to the one shown in Figure 3-8.

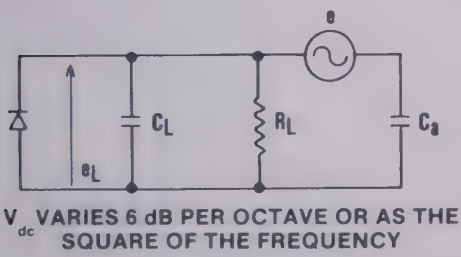


Figure 3-8. Equivalent circuit for 3 to 30 MHz.

The radio frequency voltage across the diode varies at a 6 dB per octave rate as the frequency decreases to 3 MHz. The diode having a square-law characteristic, provides a DC output voltage proportional to the square of the radio frequency voltage across the diode. The diode output sensitivity therefore decreases as the square of frequency (1/f2).

Descending still further in frequency, at approximately 3 MHz the reactance "C2" increases to the magnitude where it exceeds the resistance "R2" and the equivalent circuit reduces to approximate the schematic of Figure 3-9.

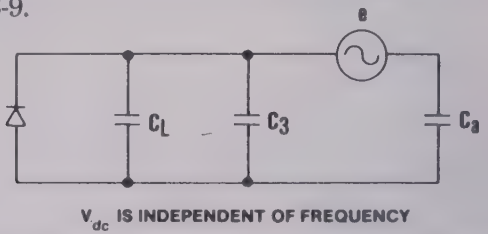


Figure 3-9. Equivalent circuit for frequencies below 3 MHz

Hence, the circuit again performs as a capacitive divider having a constant sensitivity for frequencies below 3 MHz.

Within the frequency range above 300 MHz and 1.5 GHz, the dipole characteristics are selectively modified to achieve controlled roll-off. The dipole is constructed of conductive and resistive portions, as illustrated in Figure 3-10.

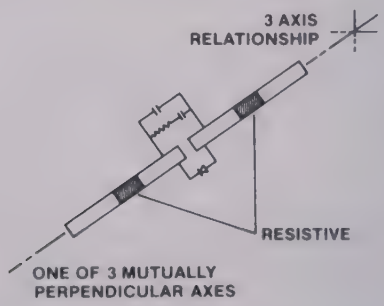


Figure 3-10. Pictorial view of dipole showing resistive and conductive segments.

The resistivity of the dipole and the concomitant decreasing sensitivity, prevents affecting the response in the high frequency region as the dipole approaches resonance. The values of capacitance and inductance for the sections of the dipole can be calculated from the average characteristic impedance for each portion of the dipole. The equation for characteristic impedance "Zo" is:

$$Z_0 = \frac{1}{H_2 - H_1} \int_{H_1}^{H_2} 120 \ln \left(\frac{2r}{a}\right) dr$$

where "H1" and "H2" define the limits of each portion of the dipole, and "a" is the effective radius of the dipole. The equation can then be integrated over the portion of the antenna in question.

Using the expression for "La" and "Ca"

$$L_a = Z_0 (8f_0)^{-1}$$

$$C_a = (\pi^2 f_0 Z_0)^{-1}$$

The frequency response of a typical unit is illustrated in Figure 3-12 (A+/-2 dB margin that conforms to the ANSI Standard is also drawn on the graph.)

Calibration factors are provided at multiple points over all frequency intervals making more precise measurements possible when the source frequency is known.

As previously stated the three dipoles are mutually orthogonal and the diodes are operated in their square law region. This region is defined as that in which the DC diode current is proportional to the square of the electric field tangential to the dipole I = K times E squared.

The conductive portion connects to a resistive film portion of the terminals of the diode. The extent and location of the resistive film portion of the dipole is selected to achieve the desired characteristics. When the frequency increases above 300 MHz, the resistance of this film predominates over the reactance of that portion of the antenna. If the entire dipole has been constructed of resistance material, the sensitivity would decrease at a 6 dB per octave rate, or 1/f2. To approximate the desired 1/f (3 dB per octave) rate, a portion only of the dipole is made resistive. The resistivity in the present case is chosen to start roll-off at 300 MHz. That portion of the conductive dipole contributes a signal to the diode that is constant over the frequency range thereby achieving the desired reduction in sensitivity to approximate 1/f. The diode operates in its square-law region and the induced voltages are made approximately equal for both conductive and resistive portions.

In the low to high frequency transition (300 MHz to 1.5 GHz range), the equivalent circuit of Figure 8 reduces to that of Figure 3-11, where the resistance "R2"is much greater than the shunting reactance of "C1" and the dipole reactance "La" is neglibible.

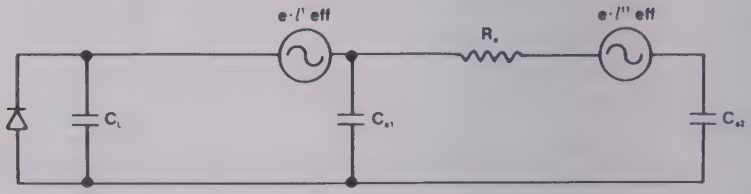


Figure 3-11. Equivalent circuit for 300 MHz to 1.5 GHz.

Under these circumstances the diode output voltage Vd becomes:

$$V_d = k\left[eL_{eff} + \frac{eL_{eff}}{f}\right]^2$$

The response of the diode sensor thus decreases as the frequency increases.

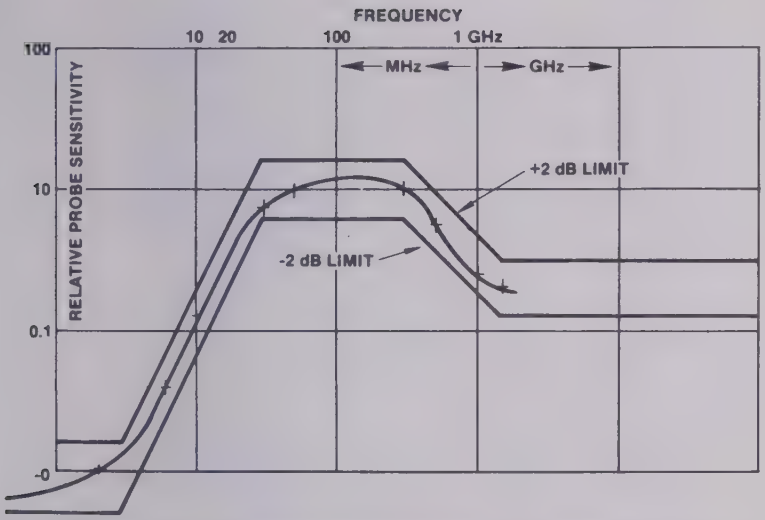


Figure 3-12. Frequency response of probe with ±2dB margins conforming to C95.1-1982 Standard.

For a free space plane wave power flow "S1" may be expressed in terms of "E" and the intrinsic impedance of free space.

$$S_1 = \frac{E^2}{\eta_0}$$

Power density "S" is equal to the sum of the squares of the coordinate field strengths divided by the space impedance = 377

$$S = \frac{E_x^2 + E_y^2 + E^2}{\eta_0}$$

$$S = K[i_x + i_y + i_z]$$

Deviation from the preceding characteristic results in a polarization ellipse ratio as well as an isotropic response deviation. The maximum deviation observed of this probe is ±0.5 dB. Very little perturbation of the field occurs. Over the major

portion of its range, the dipole is a small fraction of a wavelength and thereby couples very lightly into the field. The resistive portion of the dipole, in addition to providing the desired roll-off characteristic, also limits the coupling into the field. No resonance of the probe is observed. The out of band response of the probe, i.e. above 1.5 GHz, is a smooth monotonic curve with sensitivity decreasing as the frequency increases. Out of band response is shown in Figure 3-13.

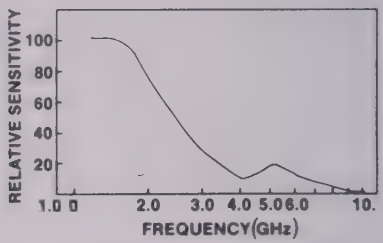


Figure 3-13. Out of band response.

The components used in the construction are beam lead diodes, chip capacitors and resistors. In addition, the diode is piggy-backed on its shunting capacitor "C2". "C2" and the diode form a loop which can couple into the magnetic field at high frequencies where the reactance is sufficiently low to permit induced currents to flow. These design selections minimize this possible coupling into the magnetic field.

Another subtle problem with which the design deals is the possible diode response to light energy. The unencapsulated beam diode can (and does) in classic manner have a response to light. This phenomena will cause down-scale readings. The sun illuminating the junction of a beam lead diode will inject minority carriers. This reduces the barrier level and produces a voltage across the junction equal to the reduction. This photo-voltaic effect is completely eliminated by encapsulating the diodes in a polyurethane foam.

Complete interchangeability exists between any and all 8600 Series Probes and Models 8616 or 8611 Meters.

3-7. METER INPUT AMPLIFIER (8616)

The output voltage of the probe pre-amplifier is transmitted through the panel connector to input amplifier U2. The gain of this amplifier is adjustable in decade steps from the front panel range switch. In the 20/100 mW/cm^2 position, the gain is unity. Gain increases in 20 dB steps as the range switch is set to 2/10 mW/cm^2 and .2/.1 mW/cm^2 positions.

A change in gain is accomplished by altering the feedback voltage as established by a divider network consisting of R10 through R13. Resistor R20 is a zero offset and the adjustment control for the amplifier. Components R9 and C4 function as a low pass filter and CR3 and CR4 prevent lockup of the amplifier if excessively large signals are applied. The amplifier output drives both the meter amplifier and the alarm circuits.

3-8. METER ALARM SECTION (8616)

Comparator U3, and transistor Q5 provide the threshold circuitry and driver for audible alarm G1. The threshold value is set from front panel potentiometer R101. Panel calibration for this potentiometer is from 0 to 100% at full scale indication and resistor R18 provides for the adjustment of the calibration.

When the signal level from the output of U2 exceeds the threshold level, transition from a negative to positive voltage occurs at the output of U3. This drives Q5 into conduction, excites G1 and sounds the audible alarm. The alarm ceases when the signal level drops below the threshold and a polarity reversal again occurs at the output of U3. The operation of this circuit is independent of the MAX-HOLD/NORMAL switch.

3-9. INDICATOR CIRCUITS (8616)

The indicator circuits consist of amplifiers U4, U5, and a meter. There are two modes of operation: MAX-HOLD and NORMAL. In the NORMAL mode, switch S103 shorts out CR11, and U4 and U5 operate as linear cascaded amplifiers with a gain of 30. This provides a recorder output at full-scale indication of 3 volts; minimum load resistance for the recorder is

1000Ω. In this mode the meter becomes the summing resistor of the feedback network and R28 is the feedback resistor.

In the MAX-HOLD mode of operation, switch S107 is open allowing CR11 to become functional within the circuit. The amplifiers now operate as a peak holding circuit in which the charge stored on C7 is proportional to the maximum power density surveyed. U5 has a MOSFET input which, together with the extremely high back resistance of CR11, prevents leakage of the charge in C7. The drift rate of this circuit is less than 0.3% of reading per minute.

When ZERO pushbutton S104 is pushed, capacitor C7 discharges and resets the circuit. CR12 prevents lock-up of the amplifiers if an exessively large signal is applied. Components R24 and C6 combine to provide an integrator which results in the panel selected "slow meter response."When S102 is positioned to "Slow,"C101 becomes active in the circuit.

In this mode the response of the meter is 3 seconds. The meter will reach 90% of true indication in 3 seconds when subjected to a step-function input. It is recommended that the 8616 NOT be operated in the slow mode, except under special conditions where this integration time is necessary.

3-10. AUTO-ZERO

The circuits of U1, Q1, and Q2 provide the automatic zero function when the ZERO pushbutton is operated. U1 amplifies the zero error signal at the output of U2. Upon closure of the zero pushbutton, the amplified error signal is applied to the gate of MOSFET Q1 and storage capacitor C2. A correction voltage, developed at the collector of Q2, is applied to the input of U101 to establish a zero meter indication. The charge on C2 is maintained when the ZERO pushbutton is released and the insulated gate of transistor Q1 prevents leakage from C2. The Max-Hold circuit is reset simultaneously with the Auto-Zero function.

3-11. POWER SUPPLY

The primary power source for the Model 8616 is a

24 volt center tapped, nickel-cadmium battery which supplies the ±12 volt circuits. Two single stage regulators provide stabilized ±7 volt supplies to reduce zero offset due to battery use and the resultant reduction in battery voltage. Components CR10 and Q3 function as the negative regulator and CR9 and Q4 function as the positive regulator. Both circuits are protected against shorting.

3-12. BATTERY CHARGING CIRCUIT

The battery charging circuit consists of power transformer T101, a standard bridge rectifier consisting of CR5 through CR8, and voltage limiting resistor R19. Standard 115 or 230 VAC is applied to power transformer T101 through AC Voltage Selector Switch S105 and line filter S101. The rectifier output voltage is applied to battery B1 in the proper polarity for battery charging and at a nominal rate of 50 ma.

The split primary windings of T101 are connected in series when AC Voltage Selector Switch S105 is in the 230 VAC position and in parallel when the switch is in the 115 V position. The front panel flag should be repositioned to indicate the line voltage corresponding to the setting of this switch.

The charge may be operated indefinitely without damage to the battery and the meter may be operated during charging. This results in a reduced charging time. Use to charge ratio is 2.5:1, therefore, every one hour of charge time will allow 2.5 hours of use. Further, 16 hours of charge time will insure a fully charged battery and a fully charged battery will permit a minimum of 40 hours of use time. The battery should be maintained in a relatively charged condition to ensure maximum life.

3-13. MODEL 8699 CHECK SOURCE

The Model 8699 utilizes a −6 volt battery to provide operating power for the O1 oscillator. O1 is physically mounted inside the waveguide and is a Dielectrically stabilized source that provides a nominal 12 GHz signal.

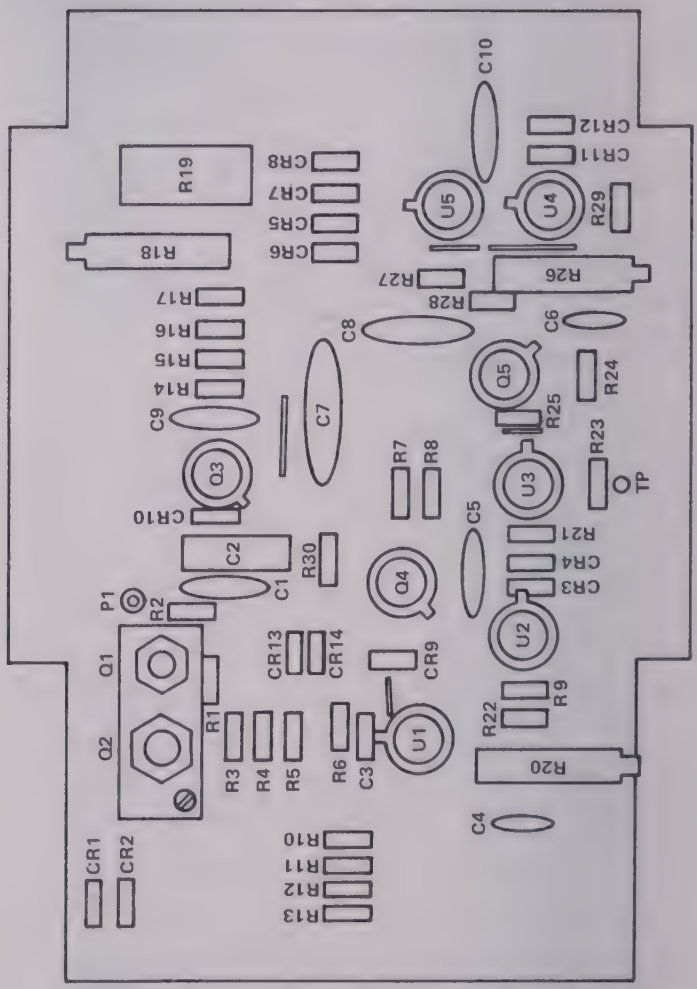


Figure 3-14. Model 8616 Radiation Monitor Schematic and PC Board Layout. (Sheet 1 of 2)

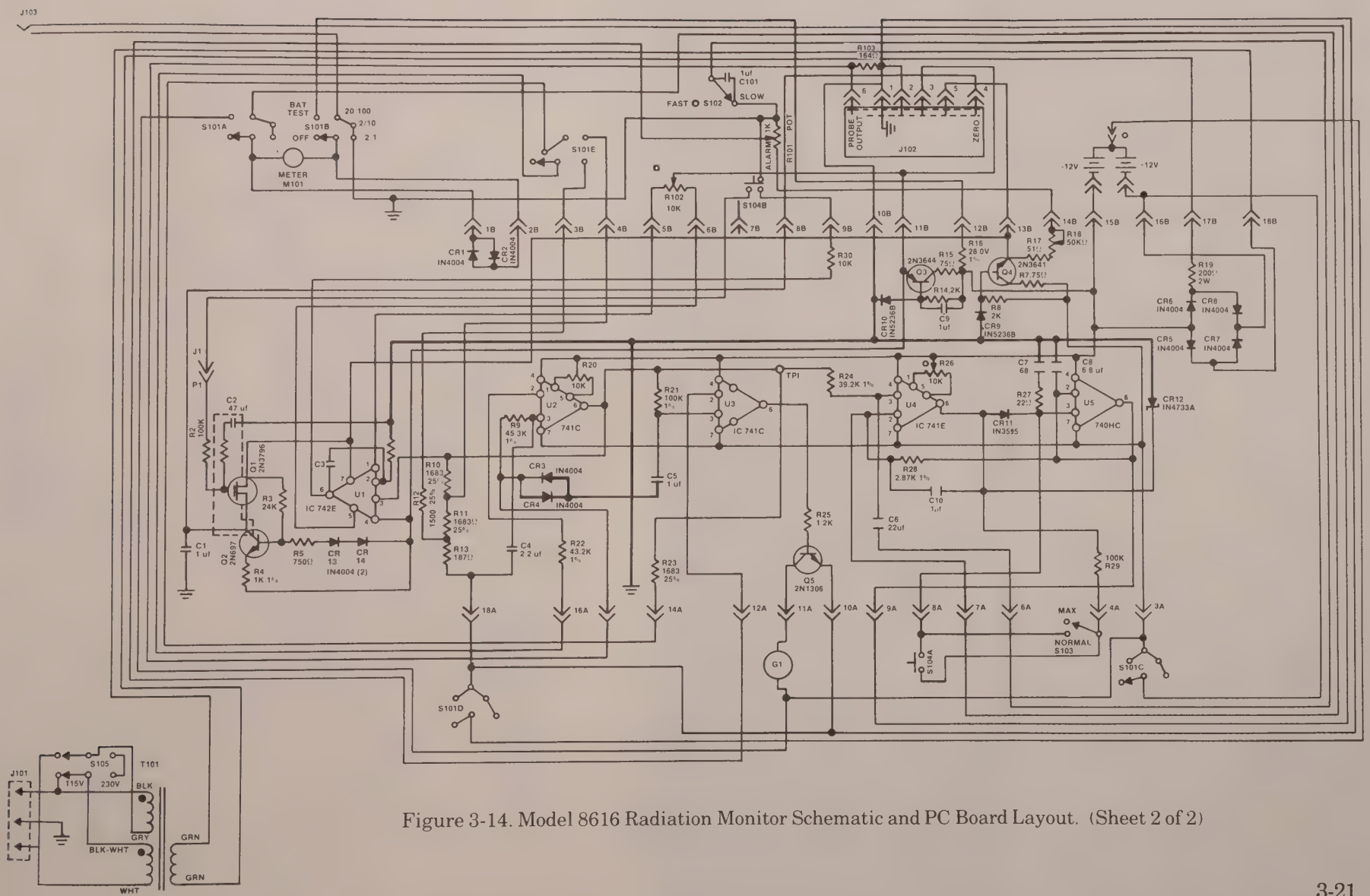


Figure 3-14. Model 8616 Radiation Monitor Schematic and PC Board Layout. (Sheet 2 of 2)

Figure 3-15. Models 8631/8633, 8621/8623 Probe Schematic

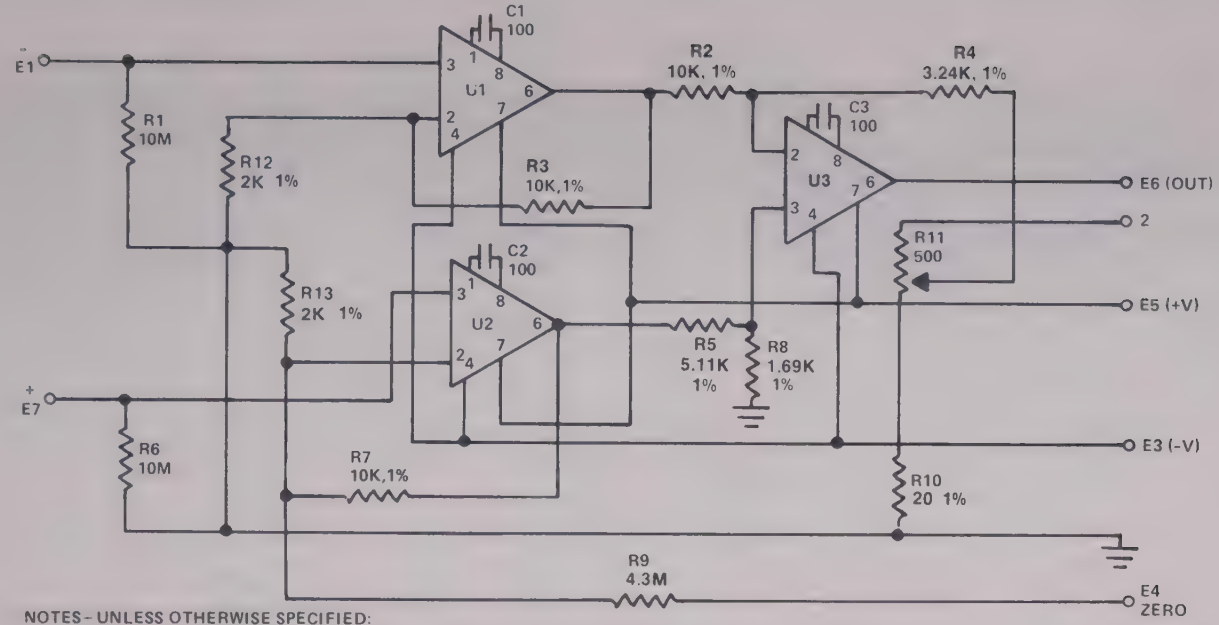
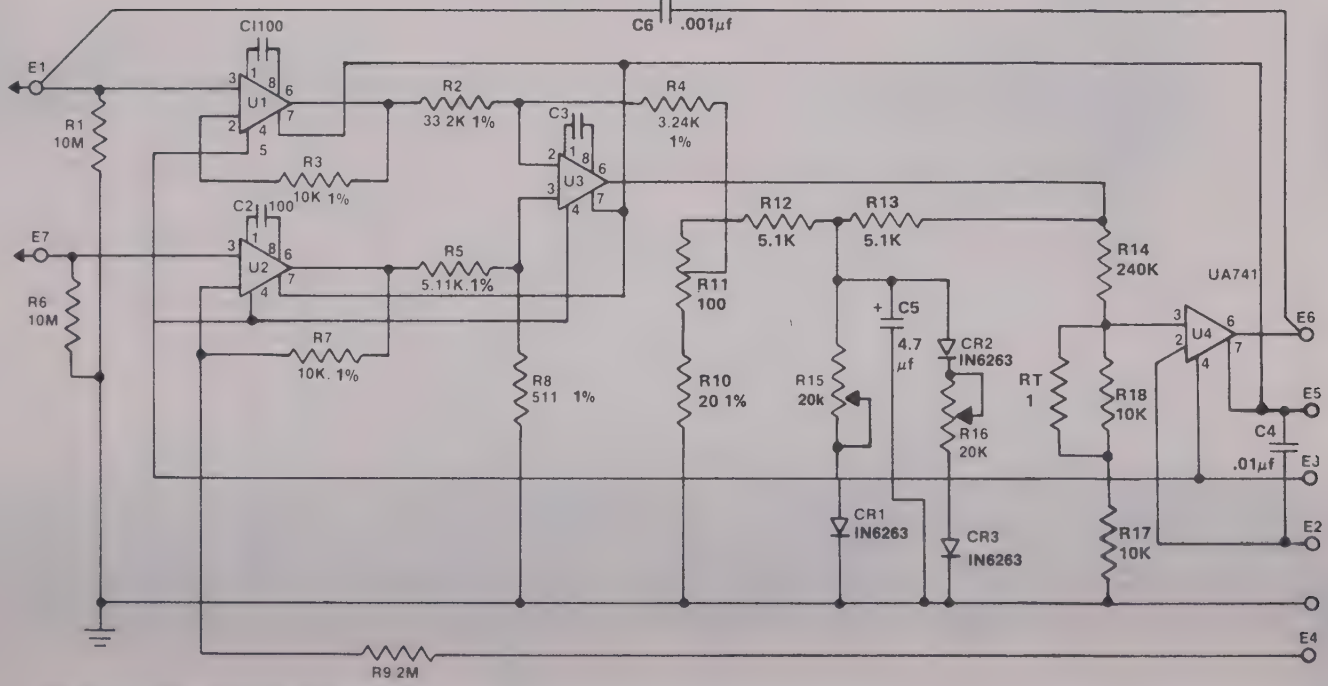


Figure 3-16. Models 8652 and 8654 Probe Schematic.



NOTES: UNLESS OTHERWISE SPECIFIED
1) RESISTOR VALUES ARE IN OHM, ⅛ WATT, 5%.
2) CAPACITOR VALUES ARE IN pf. 100V.
3) CR2 DELETED ON MODEL 8662.
4) RT1 MAY BE DELETED ON MODEL 8682.

Figure 3-17. Models 8661, 8662B and 8682 Probe Schematic.

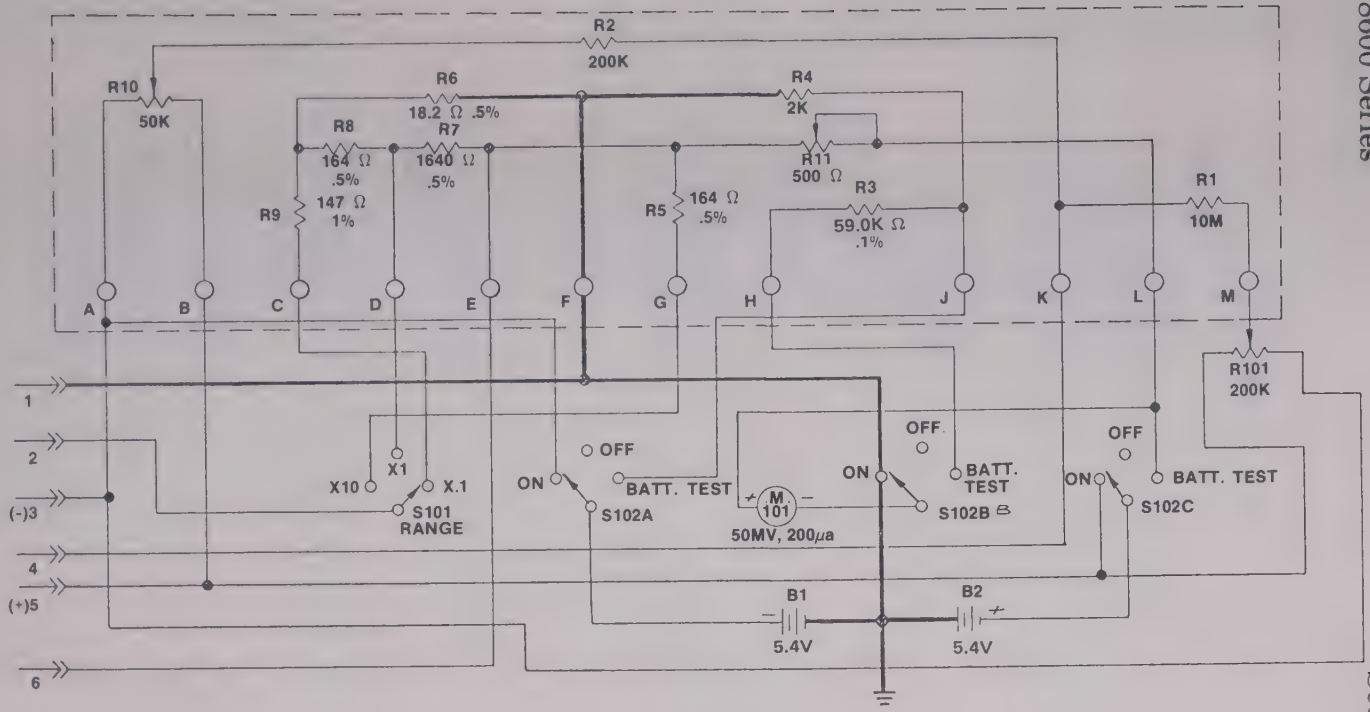


Figure 3-18. 8611 Radiation Monitor Schematic

SECTION IV
MAINTENANCE

4-1. GENERAL

This section provides information for cleaning, calibration, maintenance and troubleshooting of Narda Radiation Monitors. The Customer Service Department at Narda is available to provide recalibration and maintenance service on these units. Inquiries should be addressed to:

Customer Service Department
The Narda Microwave Corporation
Hauppauge, New York 11788

Calibration should be performed annually for meters and probes.

4-2. CLEANING

Mild solutions of household cleaners such as ammonia or dishwashing detergent can be used to loosen ground-in-dirt and grease from the exterior of the meter and probe assemblies. To clean the meter and probe assemblies, perform the procedures contained in the following paragraphs.

CAUTION

To prevent damage to the test set, do not allow moisture to collect on or within the test set. Use only damp cleaning cloths during cleaning operations.

a. Clean outer surface of the meter assembly and probe assembly with a clean cloth dampened with a mild dishwashing detergent or water solution.

b. Wipe dry using a clean, dry cloth.

c. Clean meter display window and test window using a mild ammonia and water solution.

d. Wipe dry using a clean, dry cloth.

4-3. REQUIRED TEST EQUIPMENT

The following test equipment is required for maintenance of the Model 8616 Radiation Monitor:

a. Dual Regulated Power Supply	DL 40-1A
b. Precision DC Voltmeter	Fluke Model 825A or Dana Model 4800
c. V.O.M.	Simpson 260
d. Potentiometer	10 KΩ, 1/2 W
e. Resistor	5600Ω ±5%, 1/2 W
f. Resistor	510Ω ±1%, 1/2 W
g. Resistor	45KΩ±1%, 1/2W
h. Resistor	4900Ω ±.1%, 1/2 W
i. Resistor	100Ω ±.1%, 1/2 W
j. Connector	Amphenol 91-MC6M

4-4. METER ZERO

a. Set Model 8616 to OFF and mechically zero the meter.

4-5. POWER SUPPLY TEST

NOTE

Probe should not be connected for this test.

a. Connect ± dual supply to battery terminals (battery disconnected). Power supply must have a range of ±13 to ±8.0 volts.

b. Jumper Pin 1 to Pin 6 of probe input connector.

c. Set selector switch to Battery Test and adjust ± supply voltage until meter reads at "Test Min". Power supply voltage must be between ±8 to ±9 volts.

d. Measure the positive voltage at pin 5 of the probe input connector and the negative voltage at pin 3.

e. These voltages must be between 6.3 and 7.2 volts.

f. Vary the dual supply voltage from "Test Min." to ±13 volts.

g. Negative and positive voltages at pins 3 and 5 of the probe input connector must vary less than 0.1 volt.

4-6. ZERO OFFSET ADJUSTMENTS

a. Connect battery and set mode switch to NORMAL. Maintain the supplied voltage unless otherwise specified.

b. Without a probe connected, short pin 6 of the probe input connector to pin 1.

c. Ground TP1 and adjust R26 for a zero meter indication.

d. Remove ground from TP1 and adjust R20 for a zero meter indication with range switch in most sensitive position (lowest power).

4-7. ZERO OFFSET

a. Connect Model 8623 Isotropic Probe to meter.

b. Set range switch to least sensitive range, and press zero pushbutton.

c. Set meter for zero indication by adjusting R102 while zero button is pressed.

d. Repeat step c for the other two ranges.

4-8. ALARM CALIBRATION

a. Disconnect probe and connect the test set-up shown in Figure 4-1. (Set switches to positions as shown.)

b. Set the range switch to low sensitivity (20/100 mW/cm^2) and zero the meter.

c. Set ALARM control to 100%.

d. Close switch SW1 and adjust R_T for a full scale indication on the meter.

e. Adjust R18 for an alarm threshold.

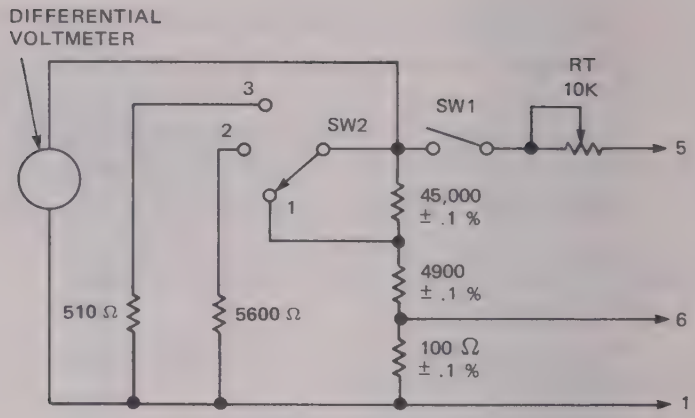


Figure 4-1. Test Set-Up

f. Open switch SW1 and set R_T to maximum resistance.

g. Set ALARM control to 50% position.

h. Close SW1 and adjust R_T to alarm threshold. Note that meter reads between 45% and 55% of full scale.

4-9. METER RESPONSE

a. Set ALARM control to 100%.

b. Set R_T for 100% indication.

c. Open switch SW1.

d. Set METER RESPONSE switch to SLOW.

e. Close switch SW1 and time the period from switch closure to 90% of full scale meter indication.

f. This period must be less than 3 seconds. Reset switch to FAST position.

4-10. RANGE CALIBRATION

a. Set Model 8616 to high sensitivity position.

b. Open switch SW1 and set switch SW2 to position 3.

c. Check for zero meter indication.

d. Close switch SW1 and record the Differential Voltmeter (DVM) reading at an exact full scale monitor meter indication. DVM reading should be between .485 and .515 volts.

e. Set 8616 to next position.

f. Set switch SW2 to position 2 and adjust R1 for exact full scale indication on 8616 meter. DVM should read between 4.85 and 5.15 volts.

g. Set 8616 to lowest sensitivity position.

h. Set switch SW2 to position 1 and adjust R1 for exact full scale indication on the Model 8616 DVM should read between 4.85 and 5.15 volts.

4-11. RECORDER OUTPUT

At a full scale meter indication, note recorder output voltage to be 3 volts ±10% at minimum 1 K load.

4-12. BATTERY CHARGE CURRENT

a. Disconnect dual supply and connect battery to Model 8616. Set power switch off.

b. Connect ammeter in series with the positive battery terminal.

c. Set 115/230 VAC switch to "115" and connect charge cable to 115 volt, 60 Hz power source.

d. Charge current should be 40 to 50 ma as indicated on the ammeter.

e. Set 115/230 VAC switch to "230."

f. Connect charge cable to 230 VAC line.

g. Charge current should be 40 to 55 ma as indicated on the ammeter.

h. Disconnect charge cable and set switch to 115 volt position.

4-13. MAXIMUM HOLD OPERATION

a. Connect the test set up shown in Figure 4-1. Set switch SW1 to open and switch SW2 to position 1.

b. Set 8616 range switch to low sensitive position and Mode switch to "Max-Hold".

c. Press zero pushbutton.

d. Close switch SW1 and adjust R_T for a meter indication of 95% full scale.

e. Open switch SW1 and note that meter indication is maintained without drift. (Less than 2% in 5 minutes.)

f. Press zero pushbutton and note that meter returns to zero.

4-14. REQUIRED TEST EQUIPMENT, MODELS 8631, 8633, 8652, AND 8654

The following equipment is required to calibrate probes from 300 kHz to 500 MHz:

			MODEL
Signal Source	.1 to 520 MHz	R&S	SMS-2
Amplifier	.15 to 300 MHz	A.R.	100L
Attenuator	50 Watt, 30 dB	Narda	765-30

Power Meter	H.P. 438A
Mount	H.P. 8482A
Crawford Cell (TEM)	Narda 8801
Radiation Monitor	Narda 8616/8611

Probes should be tested at the following frequencies:

.3 MHz	13	100	225
.5	27	125	250
1.0	40	150	275
3.0	50	175	300
10	75	200	

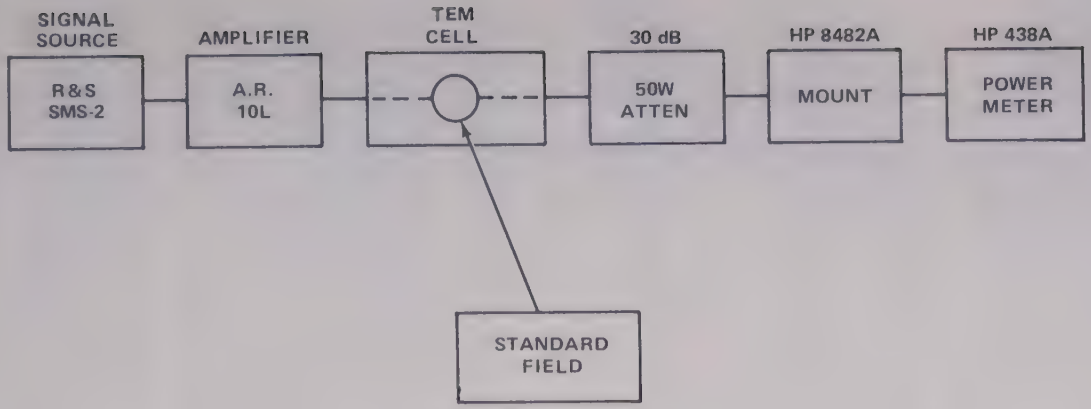


Figure 4-2. Low Frequency Probe Calibration Test Set-Up for .3 to 500 MHz

NOTE

The recommended test chamber for these calibration procedures is Narda's Model 8801 TEM Cell. The TEM Cell has the required 15 cm spacing between the Septum and the upper cell wall. An equivalent test chamber is described in the November 1974 edition of "IEEE Transactions on Electromagnetic Compatibility".

4-15. POWER REQUIREMENTS

a. Model 8631 Probes must be calibrated in a field of 1 mW/cm^2. This corresponds to a transmitted power of 1.69 watts in a 15 cm septum to wall spacing.

b. Model 8633 Probes must be calibrated in a field of 5 mW/cm^2. This corresponds to a transmitted power of 8.46 watts for the 15 cm septum to wall spacing.

c. Models 8652, 8654 and 8662B must be calibrated in a field of 10 mW/cm^2. This corresponds to a transmitted power of 16.8 watts in a 15 cm septum to wall spacing.

d. See Figure 4-2 for test setup.

4-16. INITIAL CALIBRATION PROCEDURE (27 MHz) FOR MODELS 8631 AND 8633

a. Establish appropriate field at 27 MHz using Narda Model 8801 TEM Cell or equivalent.

b. Insert probe in test chamber with sphere approximately centered within the septum and midway between the septum and the broad wall.

c. Rotate the probe through maximum and minimum and note average point of any polarization ellipse.

d. Set calibration potentiometer for an approximate mid-scale reading at 27 MHz. Record the resistance value between Pins 1 and 2 of probe connector. (The procedure to access the calibration potentiometer is outlined in paragraph 4-18.)

e. Note that the ellipse ratio max/min is less than 1.26.

4-17. FREQUENCY CALIBRATION

a. Record the reading at the average of the ellipse for all test frequencies. These readings shall be recorded as "G".

b. Determine "M" equal to:

$$\text{For 8631} \qquad M = \sqrt[1]{(G1L \times G1H)}$$

$$\text{For 8633} \qquad M = \sqrt[5]{(G1L \times G1H)}$$

Where G1L is the lowest reading and G1H is the highest reading over frequency range of 13 MHz to 200 MHz.

NOTE

For Model 8633, if white scale (0-2) is recorded for G1 then,

$$M = \sqrt[1]{(G1L \times G1H)}$$

c. Multiply all G1 readings by M to obtain G2. Record all G2 readings.

d. Multiply the recorded value of resistance (paragraph 4-16, step d) by M. Reset the calibration potentiometer to the resultant value.

4-18. CALIBRATION POTENTIOMETER ACCESS PROCEDURE

a. See Figure 4-3.

b. Remove Phillips head screw at front of probe handle. A

c. Remove set screw B from handle.

d. Rotate the handle C counter clockwise until set screw hole B lines up with potentiometer adjustment slot.

CAUTION

Do not rotate handle greater than one complete turn.

e. After adjustment, reverse procedure by rotating handle clockwise until phillips head screw can be placed in hole A.

f. Re-insert set screw B and rotate until flush with handle case.

4-19. REQUIRED TEST EQUIPMENT — 500 MHz TO 1 GHz CALIBRATIONS

The following test equipment is required to test probes from 500 MHz to 1 GHz:

a. Signal Source	R&S SMS-2
b. Amplifier	A.R. 100 HB
c. Coupler	NARDA 3020A
d. Power Meter	H.P. 438A
e. Power Meter Mount	H.P. 8482A
f. Waveguide (WR 1500 and WR 975)	NARDA SPECIAL
g. Waveguide transition (2 ea)	S.A. 11-0.5
h. Waveguide transition (2 ea)	S.A. 11-0.75
i. Stub Tuner	Maury 1878A
j. Termination	Bird 611

Equipment should be configured as shown in figure 4-4 for both 500-750 and 750 to 1000 MHz calibrations.

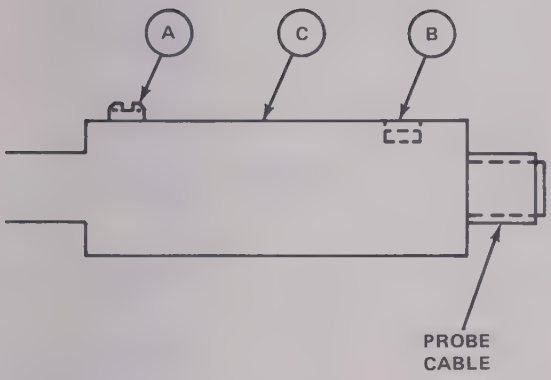


Figure 4-3. Probe Pre-Amplifier

4-20. CALIBRATION PROCEDURE — 500 MHz TO 1 GHz

a. Apply power and adjust Stub Tuner for min. reflected power at 500 MHz.

b. Insert probe through narrow wall and position elements at mid position of guide.

c. Determine mean position of ellipse ratio by rotating the probe about its axis. The mean position is position of the probe that produces a reading equal to the average of the max. and min. readings.

d. Adjust power for a 1 mW/cm^2 reading and record power meter indication.

e. Reconfigure setup for 1000 MHz and adjust tuner for minimum standing wave. Position slide at mean of remaining standing wave. Insert probe into waveguide, determine mean position and adjust power for 1 mW/cm^2 reading. Record indication.

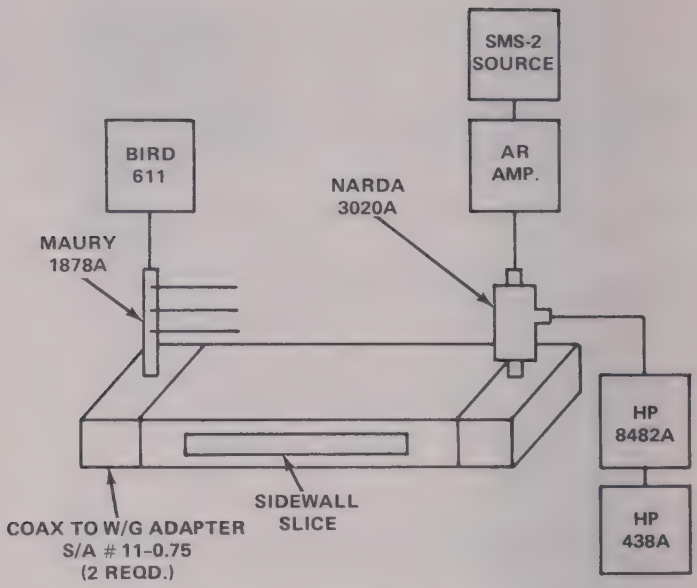


Figure 4-4. Calibration Test Set-Up for 500 MHz to 1.0 GHz

4-21. REQUIRED TEST EQUIPMENT, 1.7 TO 40 GHz CALIBRATIONS

The following equipment is required to perform calibration from 1.7 to 40 GHz.

a. Signal Source	Narda 9535
b. Signal Source	Eaton Model 445
c. 500-1000 MHz Plug-In	Eaton Model 187
d. TWT Amplifier	Servo Model S979
e. TWT Amplifier	Servo Model C979
f. TWT Amplifier	Servo Model H979
g. TWT Amplifier	Keltec Model KUR607-10
h. Isolator	Sperry Model D44S15
i. Isolator	UTE CT5155

j. Isolator	Sperry Model D44X15
k. Isolator	Sperry Model D44L15
l. Isolator	E and M Labs Model KU915LJ
m. Low Pass Filter	HP Model 360D
n. Dual Directional Coupler	Narda Model 3022
o. Dual Directional Coupler	Narda Model 3024
p. Waveguide Directional Coupler	Narda Model 1080
q. Dual Directional Coupler	Narda Model 3020A
r. Waveguide Directional Coupler	Narda Model 1079
s. Attenuators 20 dB (2 required)	Narda Model 779-20
t. Attenuator 10 dB	Narda Model 779-10
u. Power Meters (2 required) with 2 mounts	Narda Model 8400 with Model 8421 Mount
v. Power Meter	HP 432
w. Thermistor Mount	HP P487A
x. Waveguide to Coaxial Adapter	Narda Model 613A
y. Waveguide to Coaxial Adapter	Narda Model 614A
z. Waveguide to Coaxial Adapter	Narda Model 615
aa. Waveguide to Coaxial Adapter	Narda Model 612A
ab. Waveguide to Coaxial Adapter	Narda Model 601A
ac. Standard Gain Horn	Narda Model 644

ad. Standard Gain Horn	Narda Model 643
ae. Standard Gain Horn	Narda Model 645
af. Standard Gain Horn	Narda Model 642
ag. Standard Gain Horn	Narda Model 640
ah. Standard Gain Horn	S. A. 12-0-75
ai. Standard Gain Horn	Narda Model 646
aj. Standard Gain Horn	Narda Model 639
ak. Standard Gain Horn	Narda Model 638
al. Directional Coupler	Narda Model 1068-10
am. Thermistor Mount	H.P. Model K486A
an. Isolator	P&H Labs Model A3-K15210
ao. Signal Source	HP 8690+8696A
ap. Anechoic Chamber	

4-22. HIGH FREQUENCY PROBE CALIBRATION, MODELS 8621/8623

An anechoic sled should be used when establishing a standard field for calibration. This will permit the averaging of multipath interference.

Because probe calibrations are made at relatively close distances, it is necessary to use the near zone gain of the horns for the separation distances used. Table 4-2 shows the transmitted power (Pt) required for specific frequencies at noted separation distances using standard gain horns. This table should be used in conjunction with the test set-ups illustrated in Figures 4-5 through 4-9. Transmitted powers are based upon the near zone connected gain horn.

$$Pt = \frac{PaR^2 4\pi}{G}$$

Where: *Pt* = Transmitted Power
R = Separation Distances
Pa = Power Density
G = Near zone, Horn gain, numerical

Table 4-1. Transmitted Power Requirements

Frequency	Horn, Narda Model	Separation Distance (cm)	Power Density	Transmitted Power (Pt Watts)
1700	645	100	1 mw/cm^2	5
2450	645	200	1 mw/cm^2	9.89
4000	643	100	1 mw/cm^2	4.07
5000	643	100	1 mw/cm^2	2.98
6000	642	100	1 mw/cm^2	3.74
7000	642	100	1 mw/cm^2	2.81
8200	640	100	1 mw/cm^2	4.40
9300	640	100	1 mw/cm^2	3.62
10,000	640	100	1 mw/cm^2	3.15
11,000	640	100	1 mw/cm^2	2.59
18,000	639	50	0.1 mw/cm^2	.0574
26,000	638	25	0.1 mw/cm^2	.0129
40,000	637	15	0.5 mw/cm^2	.0256

For power density of 5 mw/cm^2, Transmitted Power is 5 times that indicated above for 1 mw/cm^2.

a. Record the resistance between pins 1 and 2 of the probe connector.

b. Using the appropriate test setup for the test frequencies listed in Table 4-1, obtain a power density of 1 mw/cm^2 at the center plane of the 8621 sphere. The probe axis is to be aligned with the 1 Poynting vector (direction of propagation). The probe should be rotated about its axis to the position of the average of any polarization ellipse.

c. For Model 8623 probes, establish a power density of 5 mw/cm^2 or a standard calibration field.

4-23. FREQUENCY ALIGNMENT

a. Record the readings at the average of the ellipse for all test frequencies. These readings shall be recorded as "G".

b. Determine "M" equal to:

for 8621 $$M = \frac{1}{\sqrt{(G_{iL} \times G_{iH})}}$$

for 8623 $$M = \frac{5}{\sqrt{(G_{iL} \times G_{iH})}}$$

G_{iL} is the lowest reading and G_{iH} is the highest reading over the range of 1700 MHz to 11 GHz.

c. Multiply all G_1 readings by M to obtain G_2. Record all G_2 readings.

d. Reset the resistance from Pin 1 to Pin 2 of probe connector to M times the value recorded in paragraph 4-29. For access to the calibration potentiometer, refer to paragraph 4-18.

4-24. TROUBLESHOOTING

Tables 4-2 and 4-3 provide troubleshooting charts for the Models 8616 and 8611 Radiation Meters. Trouble symptoms are based on the performance test paragraphs of this section. Reference should be made to the schematic diagram.

4-25. MODEL 8616 BATTERY CHARGING

If meter reads below Test Min., connect charging line cord and recharge battery. Use to charge ratio is 2.5:1. Every 1 hour of charge time will allow 2.5 hours of use. A fully charged battery will permit a minimum of 40 hours of use time. Sixteen hours of charge time will insure a fully charged battery. Model 8616 may be charged indefinitely without any danger of damage to either the battery or meter.

NOTE

The required charging power source voltage is indicated at the front panel line cord connector. It will indicate 115 or 230. This must correspond to the line source voltage. An internal charging switch may be reset to accomodate the available source.

4-26. MODEL 8616 BATTERY REPLACEMENT

a. Remove mounting screws at rear of case and remove unit from case.

b. Remove two screws at bottom of front panel that secure battery bracket to unit.

c. Disconnect three battery snaps and note connections to allow correct replacement.

d. Remove two screws which secure battery straps to battery bracket and remove battery straps and battery.

e. Install new battery and secure to battery bracket with strap and screws removed in step d. Insure that battery does not slide or shift position and that battery contacts do not touch battery bracket.

f. Reconnect three battery snaps as noted in step c.

g. Reassemble battery bracket to front panel and cover onto unit with new screws. Be sure that finger seals are properly seated on all four cover edges and that all screws are tightened securely.

4-27. MODEL 8611 BATTERY REPLACEMENT

a. Remove battery compartment cover from rear of unit by removing two slot head screws.

b. Remove battery holder.

c. Remove batteries from holder and replace with new batteries. Note the battery polarity positions must be in accordance with the markings in the battery compartment.

d. Replace battery holder in the compartment.

NOTE

Batteries are NEDA 1404 type, such as Eveready E164 or Mallory TR164 (Narda Part No. 88012000).

e. Test meter before connecting probes.

Table 4-2. Model 8616 Troubleshooting Chart

Symptom	Probable Cause	Remedy
Battery Test fails	Undercharged battery	Charge battery, refer to paragraph 4-35
Battery doesn't charge	a. Defective battery	a. Perform Charge Current Test, refer to paragraph 4-14. NOTE If test passed, replace battery, refer to paragraph 4-37.
	b. Defective Charging Cable	b. Replace Charging Cable.
	c. Defective charging circuit	c. Check CR5 through CR8, R19 and T101. Replace faulty component. Refer to paragraph 4-38.
Meter can not be zeroed	Defective thermocouple in probe.	Replace probe.

Table 4-2 (con't)

Alarm sounds with probe connected. (no rf power)	a. Defective thermocouple in probe.	a. Replace probe.
	b. Unit not properly zeroed	b. Zero unit, refer to paragraph 4-9.
Recorder output test fails or range calibration test fails.	Faulty amplifier stage	Determine faulty stage and replace defective component refer to paragraph 4-38.
Charge current test fails	a. Faulty charge cable	a. Replace charge cable.
	b. Faulty diodes CR5, CR6, CR7, CR8 or R19.	b. Replace faulty diodes, refer to paragraph 4-38.
Electromagnetic compatibility test	a. Cover screws not securely tightened.	a. Replace screws and tighten.
	b. Meter cover improperly assembled or gasket worn or missing.	b. Reassembly meter, cover and replace gasket refer to paragraph 4-39.
	c. Finger seals missing or improperly assembled cover.	c. Replace finger seals or reassembly properly.

Table 4-3. Model 8611 Troubleshooting Chart

Symptom	Probable Cause	Remedy
Battery Test fails	Weak batteries	Replace batteries
Meter can notbe zeroed	Defective thermo-couple in probe	Replace probe

4-28. MODEL 8616 PRINTED CIRCUIT BOARD COMPONENTS AND FRONT PANEL REPLACEMENT

a. Remove cover from unit by removing six screws.

b. Remove two screws at bottom of front panel which secure battery bracket to unit. Remove battery bracket.

c. Disconnect three battery snaps from battery terminals.

NOTE

At this point, printed circuit board components are all accessible. Continue with steps d through f to gain access to the rear of the printed circuit board as well as the front panel components.

d. Remove two meter nuts which secure printed circuit board at the top.

e. Remove the PC board screw, lock, and flat washers which secure PC board at the bottom.

f. Pull out connectors at both sides of PC board and remove PC board.

NOTE

Rear of PC board and rear of front panel are now accessible. Components may be removed using standard procedures (except for meter).

g. To reassemble unit, reverse the above procedures. When connecting the three wires, make sure that they are properly connected.

4-29. MODEL 8616 METER REPLACEMENT

a. Perform steps a through c of paragraph 4-26.

b. Remove nuts and two washers securing meter to meter cover and remove meter.

c. Unsolder meter connections to FL3 and FL4 on meter cover assembly.

d. Solder wires from FL3 and FL4 to terminals on new meter assembly.

e. Reattach meter to front panel and meter cover assembly by reattaching nuts and washers from step b.

f. Perform step f of paragraph 4-26.

4-30. MODEL 8699 BATTERY REPLACEMENT

a. Remove the two screws at the base of the unit.

b. Remove battery cover.

c. Remove battery and replace with new battery.

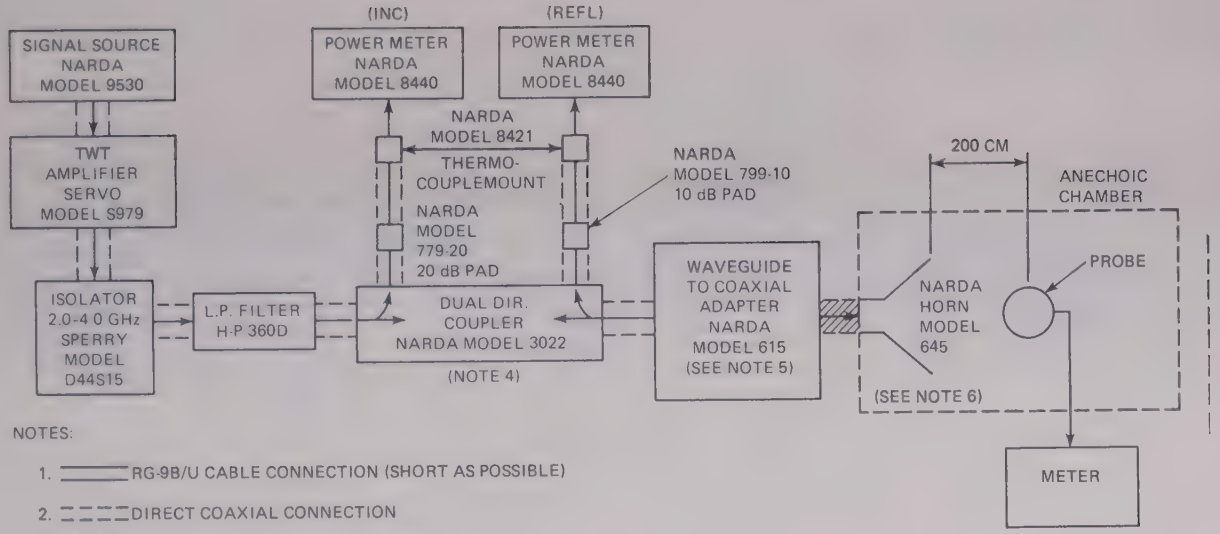
d. Replace battery cover and secure with screws.

NOTE

Insure battery terminals match with corresponding terminals inside 8699.

EATON POWER OSCILLATOR TYPE 125
ISOLATOR 1.0-2.0 GHz SPERRY MODEL D44L15
L.P. FILTER H-P 360D
(INC) POWER METER NARDA MODEL 8440
NARDA MODEL 8421 THERMO-COUPLE MOUNT
NARDA MODEL 779-20
20 dB PAD
DUAL DIR. COUPLER NARDA MODEL 3022
20db PAD
(REFL) POWER METER NARDA MODEL 8440
646 (SEE NOTE 3)
200 CM
ANECHOIC CHAMBER
NARDA PROBE
METER
NOTES:
1. RG-9B/U CABLE CONNECTION
2. DIRECT COAXIAL CONNECTION
3. WHEN MAKING CALIBRATION FROM 1.7 TO 2.6 GHz, USE MODEL 645.

Figure 4-5. Calibration Test Set-Up for 1.1 to 2.6 GHz Frequency Range



NOTES:

1. RG-9B/U CABLE CONNECTION (SHORT AS POSSIBLE)
2. DIRECT COAXIAL CONNECTION
3. DIRECT WAVEGUIDE CONNECTION
4. WHEN MAKING PROBE CALIBRATIONS FROM 3.95 TO 5.8 GHz USE MODEL 3024.
5. WHEN MAKING PROBE CALIBRATIONS FROM 2.6 TO 3.95 GHz USE MODEL 614A.
   WHEN MAKING PROBE CALIBRATIONS FROM 3.95 TO 5.8 GHz USE MODEL 613A.
6. WHEN MAKING PROBE CALIBRATIONS FROM 2.6 TO 3.95 GHz USE MODEL 644.
   WHEN MAKING PROBE CALIBRATIONS FROM 3.95 TO 5.8 GHz USE MODEL 643.

Figure 4-6. Electromagnetic Test Setup for 2.6 to 5.8 GHz

SIGNAL SOURCE NARDA MODEL 9630
TWT AMPLIFIER SERVO MODEL C979
ISOLATOR COAXIAL ADDINGTON LABS MODEL 217-0600 4.0-8.0
(INC)
POWER METER NARDA MODEL 8440
NARDA MODEL 8421 THERMO-COUPLE MOUNT
NARDA MODEL 779-20 20 dB PAD
DUAL DIR. COUPLER NARDA MODEL 3024
NARDA MODEL 779-10 10 dB PAD
(REFL)
POWER METER NARDA MODEL 8440
WAVEGUIDE TO COAXIAL ADAPTER NARDA MODEL 612A
NARDA HORN MODEL 642
100 CM
ANECHOIC CHAMBER
NARDA PROBE
METER
NOTES:
1. RG-98/U CABLE CONNECTION (SHORT AS POSSIBLE)
2. DIRECT COAXIAL CONNECTION
3. DIRECT WAVEGUIDE CONNECTION

Figure 4-7. Calibration Test Set-Up for 5.4 to 8.2 GHz Frequency Range

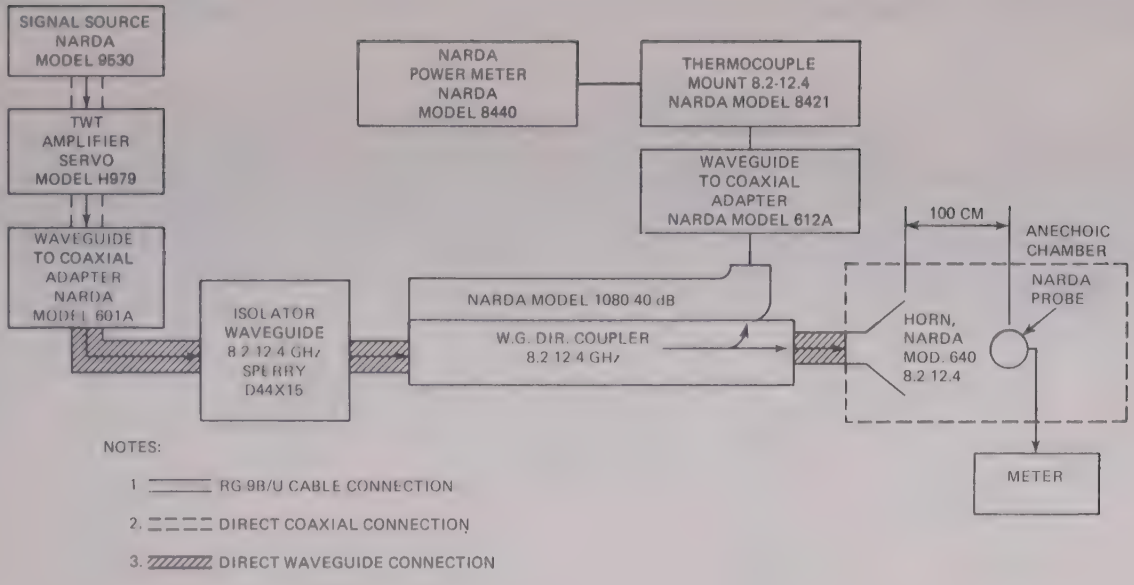


Figure 4-8. Calibration Test Set-Up for 8.2 to 12.4 GHz Frequency Range

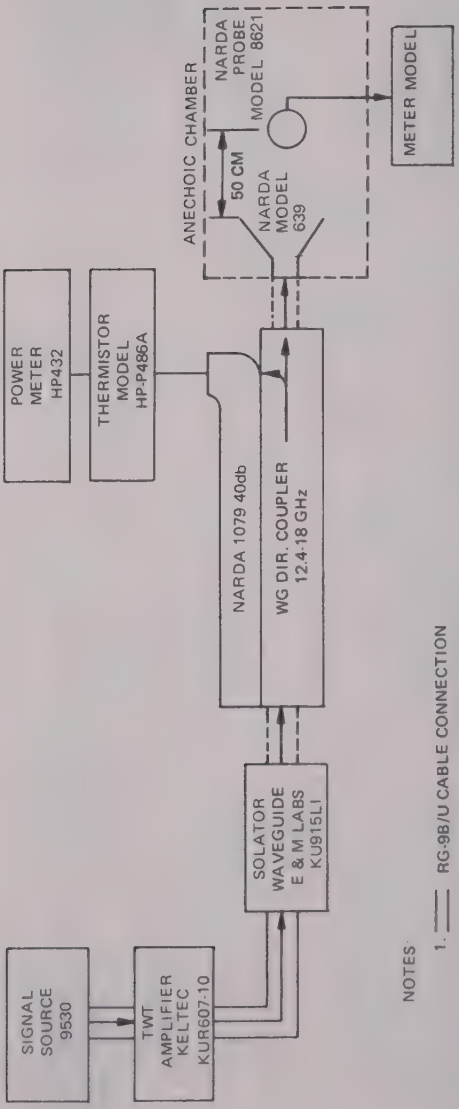


Figure 4-9. Calibration Test Set-Up for 12.4 to 18.0 GHz Frequency Range

Figure 4-10. Calibration Test Set-Up for 18 to 26 GHz Frequency Range

Figure 4-11. Calibration Test Set-Up for 26 to 40 GHz Frequency Range

SECTION V
STORAGE

5-1. INTRODUCTION

This section contains information for storing the Radiation Monitors. For short-term storage, the components of the system should be stowed in the carrying case. For long-term storage, prepare the system in accordance with the following procedure:

CAUTION

Do not place the system, operating or non-operating in an area where fields are expected to exceed a 10 mW/cm^2 reading as damage to the test set may result.

a. Model 8611 Meter

(1) On 8611 meter, loosen two captive screws and remove cover.

(2) Carefully remove two batteries from battery holder.

(3) Replace battery holder in battery compartment of 8611 meter assembly.

(4) Replace cover and fasten with two captive screws.

b. Models 8611 and 8616

(1) Disconnect probe assembly from meter assembly.

(2) Stow meter assembly, probe assembly, manual and batteries in carrying case.

(3) Store system in a clean, dry area.

SECTION VI

PREPARATION FOR RESHIPMENT

6-1. INTRODUCTION

This section contains procedures for preparing the system for shipment.

6-2. PROCEDURES

To prepare the system for shipment perform the procedures contained in the following subparagraphs:

a. Disconnect connector of probe assembly from connector of meter assembly.

b. Stow meter assembly, probe assemblies, and manual in the carrying case.

c. Wrap the carrying case in moisture proof paper or plastic film and securely tape the wrapping.

d. Place the wrapped package into a suitable cardboard container with at least three inches of foam padding all around.

e. Securely tape the container.

f. Mark the container in accordance with applicable regulations.

SECTION VII
REPLACEMENT PARTS LIST

7-1. INTRODUCTION

This section provides a complete listing of the replaceable parts of this unit. The listing contains the necessary ordering information. Parts are listed in alpha-numerical order by reference designator. Complete descriptions of each component are provided in addition to the manufacturer's code and Narda part number in order to facilitate ordering of replacement parts. (See Tables 7-1 and 7-2.)

7-2. ORDERING INFORMATION

If it is desired to order replacement parts from the instrument manufacturer, address the order to:

SALES DEPARTMENT
The Narda Microwave Corporation
435 Moreland Road
Hauppauge, New York 11788

When ordering a part in this manner, the following information should be provided:

a. Model and serial number of the instrument.

b. Narda part number.

c. Reference designation.

d. Description.

When ordering components or parts not listed in Table 7-2, a complete description of the part, including its function and location should be provided with the model and serial number of the instrument.

7-3. CUSTOMER REPAIR SERVICE

Repairs or recalibration of Narda Products are performed by the Customer Service Department at the factory; however, before returning any unit, contact the Narda Microwave Corporation or the local Narda Sales Representative in your area for shipping instructions.

Table 7-1. Manufacturer's Code

Manufacturer's Supply Code	Name	Address
01121	Allen Bradley Co.	El Paso, TX
01295	Texas Instruments, Inc.	Dallas, TX
04713	Motorola Semiconductor	Phoenix, AZ
05245	Corcom	Chicago, IL
31433	Union Carbide	Greenville, SC
13715	Fairchild	San Rafael, CA
12697	Clarostat Mfg. Co., Inc.	Dover, NH
24546	Corning Glass Works	Bradford, PA
28480	Hewlett Packard	Palo Alto, CA
30983	Mepco/Electra	San Diego, CA
56289	Sprague	North Adams, MA
80294	Bourns, Inc.	Riverside, CA
82349	Switchcraft, Inc.	Chicago, IL
95146	Alco Electronic Products	Lawrence, MA
95275	Vitramon, Inc.	Bridgeport, CT
99899	Narda Microwave Corp.	Hauppauge, NY
91637	Dale Electronics	Norfolk, NE
93790	Cornell Dublier	New Bedford, MA

Table 7-2. Replaceable Parts List

Ref. Des.	Description	Mfg. Code	Manufacturer's Part Number	Narda Part No.
	Model 8616 Meter			
B1	Battery	99899		88011000
C1	Capacitor, 1 uf, 25 VDC, ±20%	56289	5C023105X0250B3	80139105
C2	Capacitor, .47 uf, 100 VDC	84411	X46473UW.47	80221002
C3	Capacitor, .1 uf, 50 VDC, ±20%	95275	CK05BX104M	80187005
C4	Capacitor, 2.2 uf, 20 VDC	31433	T368A225M020AS	80198004
C5	Capacitor, 1 uf, 50 VDC	56289	5C023105X0250B3	80139105
C6	Capacitor, 22 uf, 15 VDC	31433	T368B226M015AS	80198003
C7	Capacitor, .68 uf, 100 VDC	84411	X463UW.68MFD	80221000
C8	Capacitor, .68 uf, 6 VDC	31433	T368A685M06AS	80198012
C9, C10	Capacitor, 1 uf, 50 VDC	56289	5C023105X0250B3	80139105

Table 7-2. Replaceable Parts List (Cont)

CR1	Diode	01295	IN4004	84568004
CR2	Diode	01295	IN4004	84568004
CR3	Diode	01295	IN4004	84568004
CR4	Diode	01295	IN4004	84568004
CR5	Diode	01295	IN4004	84568004
CR6	Diode	01295	IN4004	84568004
CR7	Diode	01295	IN4004	84568004
CR8	Diode	01295	IN4004	84568004
CR9	Diode	04713	5236B	84591000
CR10	Diode	04713	5236B	84591000
CR11	Diode	04713	IN3595	84704000
CR12	Diode	04713	IN4733A	84540005
CR13, CR14	Diode	01295	IN4004	84568004
G1	Son. Alert Assy.	99899		306934
J101	Power Line Filter	05245	1B4	81659000
J102	Connector Assy.	02660	91-PC6F	81523041
J10-3	Recorder Assy.	99899		306948
M101	Meter	99899		82528002
Q1	Transistor	04713	2N3796	89018097
Q2	Transistor	13715	2N697	89018004
Q3	Transistor	13715	PN3644	89018010
Q4	Transistor	13715	PN3641	89018009
Q5	Transistor	04713	2N1306	89018026

Table 7-2. Replaceable Parts List (Cont)

Ref. Des.	Description	Mfg. Code	Manufacturer's Part Number	Narda Part No.
R1	Resistor, Fixed Comp. 1MΩ, 1/4W, 5%	01121	RC07GF105T	83015121
R2	Resistor, Fixed Comp. 100KΩ, 1/4W, 5%	01121	RC07GF104T	83015097
R3	Resistor, Fixed Comp. 24KΩ 1/4W, 5%	01121	RC07GF243T	83015082
R4	Resistor, Metal Oxide 1KΩ, 1/8W, 1%	91637	RN55D1001F	83049192
R5	Resistor, Fixed Comp. 750KΩ, 1/4W, 5%	01121	RC07GF751T	83015046
R6	Resistor, Metal Oxide 10KΩ, 1/8W, 1%	91637	RN55D1002F	83049288
R7	Resistor, Fixed Comp. 75Ω, 1/4W, 5%	01121	RC07GF750T	83015022
R8	Resistor, Fixed Comp. 2KΩ, 1/4W, 5%	01121	RC07GF202T	83015056

Table 7-2. Replaceable Parts List (Cont)

R9	Resistor, Metal Oxide 45.3KΩ, 1/8W, 1%	91637	RN55D4533F	83049350
R10	Resistor, Metal Oxide 16.8KΩ, 1/8W, 1/4%	24546	RN55C1683C	83170012
R11	Resistor, Metal Oxide 1683Ω, 1/8, 1/4%	24546	RN55C1.683KC	83170011
R12	Resistor, Metal Oxide 1500Ω, 1/8W, 1/4%	24546	RN55C1501C	83170010
R13	Resistor, Metal Oxide 187Ω, 1/8W, 1/4%	24546	RN55C1870C	83170009
R14	Resistor, Fixed Comp. 2K, 1/4W, 5%	01121	RC07GF202T	83015056
R15	Resistor, Fixed Comp. 75Ω, 1/4W, 5%	01121	RC07GF750T	83015022
R16	Resistor, Metal Oxide 28.0K, 1/8W, 1%	91637	RN55D2803F	83049330
R17	Resistor, Fixed Comp. 51K, 1/4W, 5%	01121	RC07GF513T	83015090
R18	Resistor, Var. 50K, 1W, 10%	30983	ET34P503-023	83128012
R19	Resistor, Fixed Comp. 200Ω, 2W, 5%	01121	RC42GF201T	83011032

Table 7-2. Replaceable Parts List (Cont)

R20	Resistor Var. 10KΩ, 1W, 10%	30983	ET34P103-203	83128010
R21	Resistor, Fixed Comp. 100KΩ, 1/8W, 1%	91637	RN55D1004F	83049383
R22	Resistor, Fixed Comp. 43.2KΩ, 1/8W, 1%	91637	RN55D4323F	83049348
R23	Resistor, Metal Oxide 1683Ω, 1/8W, 1/4%	24546	NC551.683KC	83170011
R24	Resistor, Metal Oxide 39.2KΩ, 1/8W, 1%	91637	RN55D3923F	83049344
R25	Resistor, Fixed Comp. 1.2KΩ, 1/4W, 5%	01121	RC07GF122T	83015051
R26	Resistor, Var. 10KΩ, 1W, 10%	30983	ET34P103-023	83128010
R27	Resistor, Fixed Comp. 22Ω, 1/8W, 5%	01121	RC07GF220T	83015009
R28	Resistor, Metal Oxide 2.87KΩ, 1/8W, 1%	91637	RN55D2871F	83049236
R29	Resistor, Fixed Comp. 100KΩ, 1/4W, 5%	01121	RC07GF103T	83015097
R30	Resistor, Fixed Comp. 10KΩ, 1/4W, 5%	01121	RC07GF102T	83015073
R101	Resistor, Var. 1000Ω, 2W, 10%	12697	83123018	83123018
R102	Resistor, Var. 10KΩ	80294	3059J-103M	83161004
R103	Resistor, Metal Oxide 164Ω, 1/8W, 1%	91637	RN55D1640F	83068117

Table 7-2. Replaceable Parts List (Cont)

S101	Switch, Rotary	99899		83709000
S102	Switch, SPDT	95146	MST-105D	83530000
S103	Switch, SPDT	95146	MST-105D	83530000
S104	Switch, DPDT Push-Button	95146	MSP-205R	83712001
S105	Switch, Slide 115-230	82349	46206LF	83509001
T101	Transformer	99899		84035000
U1	Integrated Circuit	07263	741E	84727000
U2	Integrated Circuit	07263	741E	84727000
U3	Integrated Circuit	07263	741C	84548000
U4	Integrated Circuit	07263	741C	84548000
U5	Integrated Circuit	07263	740HC	84705000
		Models 8621, 8623, 8631, 8633		
C201	Capacitor, 100pf, 5% 500 WVDC	93790	CD15E101J0	80115027
R201	Resistor, Fixed Comp. 620, 1/4W, 5%	01121	RC07GF621T	83015044
R202	Resistor, Fixed Comp. 470K, 1/4W, 5%	01121	RC07GF474T	83015113
R203	Resistor, Variable 20K	80294	3292P-1-203	83195010
U101	Integrated Circuit	13715	LM208AH	84728000

Table 7-2. Replaceable Parts List (Cont)

Models 8661, 8662B, 8682 Probes

R1	Resistor, Fixed Comp. 10MΩ, 1/8W, 5%	01121	RC05GF106T	83164159
R2	Resistor, Metal Oxide 33.2KΩ, 1/8W, 1%	91637	RN55D3323F	83049337
R3	Resistor, Metal Oxide 10KΩ, 1/8W, 1%	91637	RN55D1002F	83049288
R4	Resistor Metal Oxide 3.24KΩ, 1/8W, 1%	91637	RN55D3241F	83049241
R5	Resistor, Metal Oxide 5.1K Ω , 1/8W, 1%	91637	RN55D5111F	83049260
R6	See R1			
R7	See R3			
R8	Resistor, Metal Oxide 511Ω, 1/8W, 1%	91637	RN55D5110F	83049165
R9	Resistor, Fixed Comp. 2MΩ, 1/8W, 5%	01121	RC06GF205T	83164142
R10	Resistor, Metal Oxide 20Ω, 1/8W, 1%	91637	RN55D0200F	83049030
R11	Resistor, Variable 500Ω	80294	3292P-1-501	83195005
R12	Resistor, Metal Oxide 5.1K Ω , 1/8W, 5%	01121	RC066F511T	83164142
R13	See R12			
R14	Resistor, Metal Oxide 430KΩ, 1/8W, 5%	01121	RC05GF435T	83164126
R15	Resistor Variable 20KΩ	80294	3359W-1-203	83143000

Table 7-2. Replaceable Parts List (Cont)

R16	Resistor Variable 20KΩ			83171011
R17	Resistor, Fixed Comp. 27KΩ, 1/8W, 5%	01121	RC05GF273T	83164097
C1	Capactitor, 100 pf, 100V, 5%	93790	CD19E101J0	80115226
C2	See C1			
C3	See C1			
C4	Capacitor, .01μf	56289	CK05BX103K	80187000
C5	Capacitor, 4.7μf	56289	196D475X9010HA1	80230020
C6	Capacitor, .001μf 200 VDC, ±10%	95275	CK05BX102K	80187031
U1	Integrated Circuit	13715	LM208AH	84728000
U2	See U1			
U3	See U1			
U4	Integrated Circuit	13715	μA741	84548000
CR1	Diode	28480	IN6263	84585004
CR2	See CR1			
CR3	See CR1			
	Model 8652 Probe			
R1	Resistor, Fixed Comp. 10M, 1/8W, 5%	01121	RC05GF106T	83164159
R2	Resistor, Metal Oxide 10K, 1/8W, 1%	91637	RN55D1002F	83049288

Table 7-2. Replaceable Parts List (Cont)

R3	See R2			
R4	Resistor, Metal Oxide 3.24K, 1/8W, 1%	91637	RN55D3241F	83049241
R5	Resistor, Metal Oxide 5.11KΩ, 1/8W, 1%	91637	RN55D5111F	83049260
R6	See R1			
R7	See R2			
R8	Resistor, Metal Oxide 1.69KΩ, 1/8W, 1%	91637	RN55D1691F	83049214
R9	Resistor, Metal Oxide 4.3MΩ, 1/8W, 5%	01121	RC05GF435T	83164150
R10	Resistor, Metal Oxide 20Ω, 1/8W, 1%	91637	RN55D0200F	83049030
R11	Resistor, Variable 500Ω	80294	3292P-1-501	83195005
R12	Resistor, Metal Oxide 2KΩ, 1/8W, 1%	91637	RN55D2001F	83049221
R13	See R12			
C1	Capacitor, 100 pf, 100V, 5%	93790	CD15E101J0	80115226
C2	See C1			
C3	See C1			
U1	Integrated Circuit	13715	LM208AH	84728000
U2	See U1			
U3	See U1			

Table 7-2. Replaceable Parts List (Cont)

	Model 8699 Test Source			
B1	Battery, NEDA 908, 6 volts		509	88016000
O1	Oscillator, 12.00 GHz	99899		87304000
	Model 8611 Meter			
B1,B2	Battery, 5.4 volts	90201	TR164	88012000
M1	Meter	99899		82553001
R1	Resistor, Fixed Comp. 10 Meg, 1/4 w, 5%	01121	RC07GF305T	83015145
R2	Resistor, Fixed Comp. 200k, 1/4 w, 5%	01121	RC07GF204T	83015104
R3	Resistor, Metal Oxide 59kΩ, 1/8 w, 1%	91637	RN55D5902F	83049361
R4	Resistor, Metal Oxide 2k, 1%	91637	RN55D2001F	83049221

Table 7-2. Replaceable Parts List (Cont)

R5	Resistor, Metal oxide 164Ω, 1/2%	01121	RN55C1640C	83144000
R6	Resistor, Metal Oxide 18.2Ω, 1/2%	01121	RN55C18.2C	83144002
R7	Resistor, Metal Oxide 1640, 1/8 w, 1/2%	01121	RN55C1641F	83144002
R8	Resistor, Metal Oxide 164Ω, 1/8 w, 1/2%	01121	RN55C1640F	83144000
R9	Resistor, Metal Oxide 147Ω, 1%	01121	RN55C1470F	83049113
R10	Resistor, Variable 50k	80924	3006P-1-503	83240011
R101	Resistor, Variable 200k, 20%	90201	MLC25L	83211000
S101	Switch, Toggle, Min, 3PDT	95146	MST-205PA	83713000
S102	Switch, ON-OFF Momentary	95146	MST-305H	83714000

MP MASTER
MA27939